The Missing Pages In This
Volume Are Advertisements

Concrete

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Nation Constructs 10,200 Miles of Concrete Roads in 1930

Road Mileage 16 Per Cent Above 1929—Street Paving Lower—Quality and Construction Methods Improve—Specifications Tighten Up—Untangling Traffic Congestion—Prospects Good for 1931

THE first nationwide attempt to soften the effect of a major business depression by speeding up on public construction work met with a splendid response from state highway departments in 1930.

Highway Contracts 16 Per Cent Above 1929

With a few exceptions, the monthly reports of contracts awarded for concrete road construction during 1930 exceeded the yardage reported in the corresponding month of 1929. If contracts awarded in the month of December, on which complete reports are not as yet available, are equal to the awards in December, 1929, the total yardage of concrete highways for which contracts were let in 1930 will amount to about 108,000,000 sq. yd. This will be about 16 per cent in excess of the 92,816,794 sq. yd. awarded in 1929.

Street Paving Work Drops Off

In contrast to the excellent showing in state and county highway work, concrete street and alley paving work fell substantially below the record for 1929.

With December figures incomplete, the indicated yardage of concrete street and alley paving work for which contracts were awarded during 1930 will amount to about 36,000,000 sq. yd. This figure is about 24 per cent below the total of 47,203,957 sq. yd. awarded in the full year of 1929.

Total Pavements Ahead of 1929

With December figures partly estimated, the total yardage of concrete pavements, including roads, streets and alleys, should be about 144,000,000 sq. yd. in 1930, or about 3 per cent in excess of the 1929 total of 140,020,751 sq. yd.

10,200 Miles of Concrete Highway

The vast volume of construction work involved in the contracts awarded during 1930 may be visualized in terms of mileage. The total concrete road awards for the year have added the equivalent of 10,200 miles of 18-foot pavement to the nation's improved highway system.

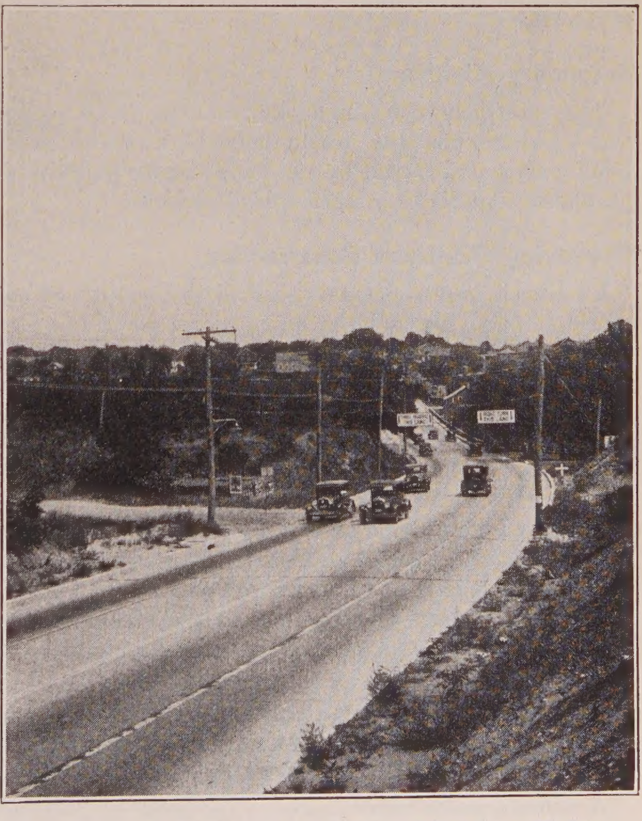
The total concrete street and alley awards in 1930 are the equivalent of a 30-foot street more than 2,000 miles long.

Relieving Traffic Congestion

In the wealthier states, in most of which the primary highway systems are in large part completed, more and more attention is being paid to the relief of traffic congestion.

Highways are being widened not only in the vicinity of large cities, but for the full length of inter-city roads in sections where large cities are numerous.

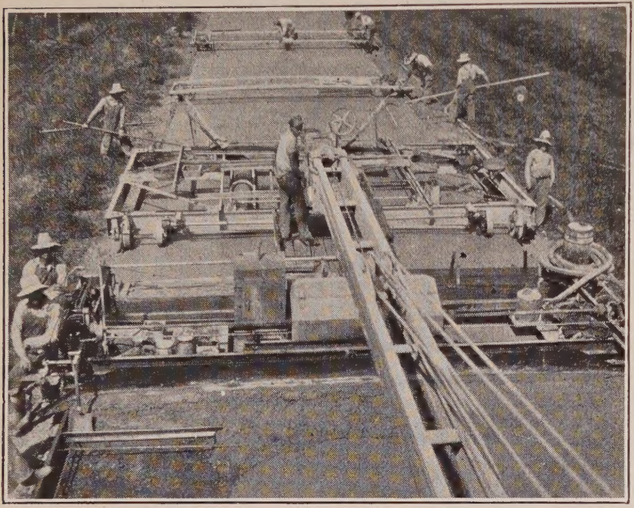
The construction of traffic relief roads parallel to



Main inter-city highways are being widened to 40 feet through roads, but one or two miles from them, is another method employed in relieving heavy-traffic roads.

Grade separation and the removal of bottle-necks constitute additional activities which are producing commendable results. As pointed out by Robert Kingery, in an article in the November, 1930, issue of CONCRETE, pages 17-19, the construction of grade separations at main highway intersections located in thickly populated areas will do more to relieve traffic congestion than is possible by any other means at anywhere near the same cost.

Separations between main highways and railways are likewise receiving attention. The state highway department of Pennsylvania alone reports the construction of 26 highway-railway grade separation structures in the past year.



Machine finishing is now compulsory in 32 states

Secondary Highways

The construction of single-lane concrete roads to connect rural sections with nearby markets is another recent development undertaken by state and county highway departments, especially in agricultural sections.

Improving Quality of Construction

Continued improvement is seen in the quality of construction, partly through the more general use of improved equipment, partly through further improvement in methods of making, placing and curing concrete, and partly through the higher quality of portland cement itself.

Strengthening the Specifications

The trend toward the greater use of high grade equipment is seen in the fact that 32 states now require machine finishing of concrete pavements, compared with 26 states a year ago. Sixteen states continue to allow hand finishing methods, at the option of the contractor, compared with 17 states a year ago.

In the matter of strength requirements, 16 states now demand a definite 28-day strength (14 days in one instance), compared with 13 states a year ago.

A definite water-cement ratio is specified by 24 states, compared with 17 states a year ago; and 29 states now specify a minimum quantity of cement per cubic yard of concrete.

An interesting development in the mixing of concrete is seen in the fact that all states (including the District of Columbia) now specify a minimum mixing time, the length of time ranging from 50 seconds to 1¾ minutes. Furthermore, all states except Nevada and Wyoming now require the attachment of a timing device to control the time of mixing, and all states except Idaho require the mixing water to be measured.

Curing of Concrete Pavements

Curing pavements by covering with burlap and sprinkling, curing by covering with wet earth, hay or straw, and curing by ponding continue to be the methods most frequently mentioned in specifications. It is known, however, that curing by surface coatings is permitted in an increasing number of states, even though such methods may not be specifically mentioned.

Thickened Edges Almost Universal

Cross-sections of concrete highways are now required to have some type of thickened edges in all but seven states. In this respect there has been no change from a year ago.

The International Road Congress

One of the important events during the year was the convening of the Sixth International Road Congress in Washington from October 6th to 11th, inclusive.

Notable among the papers presented at this congress was a report of American engineers on "Results Obtained by the Use of Cement." The report, which consists of a comprehensive analysis of American practice, was prepared by Frank T. Sheets, chief highway engineer, Illinois Department of Public Works and Buildings; Roy W. Crum, director, Highway Research Board, National Academy of Sciences; E. M. Fleming, manager, Highways Bureau, Portland Cement Association; Arthur N. Johnson, dean, College of Engineering, University of Maryland; Clifford Older, consulting engineer, Chicago, Ill.; and Raymond E. Toms, principal highway engineer, U. S. Bureau of Public Roads. The full text of the report may be obtained in publications issued by the U. S. Bureau of Public Roads.

The conclusions adopted by the International Road Congress with respect to concrete roads are printed on another page in this issue.

Prospects for 1931

So far as concrete road construction is concerned, so great an effort was put forth by state highway departments toward speeding up construction during 1930 that only a small increase can be expected for 1931. In the matter of street and alley pavements, 1931 should see considerable improvement over 1930, in view of the decided retrenchment in that class of work during the past year.

The expectation of more street paving in 1931 is based in part on the change in the voters' attitude toward bond issues, as indicated by the November elections. In contrast to the spring elections, the voters took favorable action on most of the bond issues submitted at the November elections.

Precast Light-Weight Concrete Slabs Solve Bridge Floor Problem

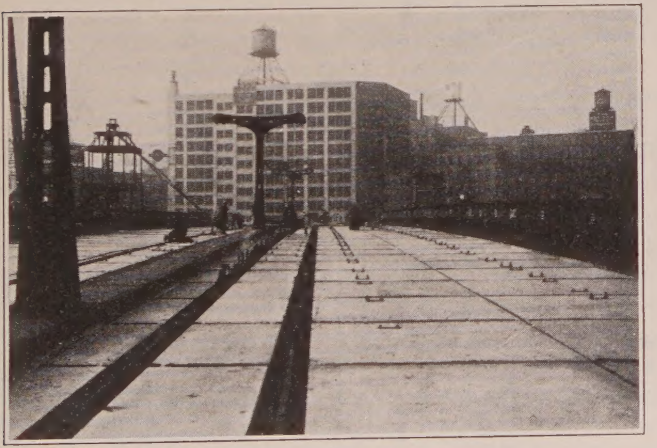
Developed in Chicago for Roadways and Sidewalks of Bascule Bridges—Slabs Cast Under Electric Vibration—Great Strength in 24 Hours With High-Early-Strength Cement

A NEW type of bridge floor, consisting of large precast slabs of light-weight concrete welded to the steel floor system, has been developed by the Division of Bridges of the City of Chicago, under the direction of Loran D. Gayton, city engineer, and Major Paul Schioler, city bridge engineer.

Slabs of the nature here described were first specified for the sidewalks of the Clark Street bridge in 1929. The Wabash Avenue bridge, now under construction over the main branch of the Chicago River, has similar slabs over the entire movable part of the bridge floor, the roadway as well as the sidewalks.

Slab Sizes

A typical roadway slab of the largest size is shown in the illustration. These are 102 sq. ft. in area, and 28 of this size were required. Twenty-eight others are each 73 sq. ft. in area, and 56 much smaller ones were placed between the street car tracks and rails. Thirty sidewalk slabs were required, the majority of them 98 sq. ft. in area. The roadway slabs have a total thickness of 5¾ in., including the 1¼-in. top wearing surface. The sidewalk slabs, entirely of light-weight concrete, are 2½ in. thick. The roadway slabs are heavily reinforced with steel bars in top and bottom, and with stirrups. The sidewalk slabs are reinforced with two layers of welded wire fabric, held 1 in. apart.



Roadway slabs in position, bridge closed

The Concrete Mixtures

The cement and aggregates employed in the slabs were a 1:1½:2½ mixture of Incor high-early-strength cement, No. 3 torpedo sand, and coarse haydite, with 4¼ gallons of water to the sack of cement. This mixture was used for the sidewalk slabs and for all but the top wearing coat of the roadway slabs. This sand-haydite concrete had an average weight of 117 lb. per cu. ft.

For the top wearing surface on the roadway slabs the same cement was employed in a 1:1:2 mixture having fine red granite screenings as the fine aggregate, and red granite chips up to ½-inch size as the coarse material. This mixture had an average weight of 160 lb. per cu. ft.

Strength of Concrete

Tests of compressive strength conducted at the city's testing laboratory on 6 by 12-in. cylinders indicated highly satisfactory results. The following tabulation gives the average, high and low on groups of six specimens each. These tests are not progressive, since each group of six cylinders was made from a separate batch of concrete. The test results follow:

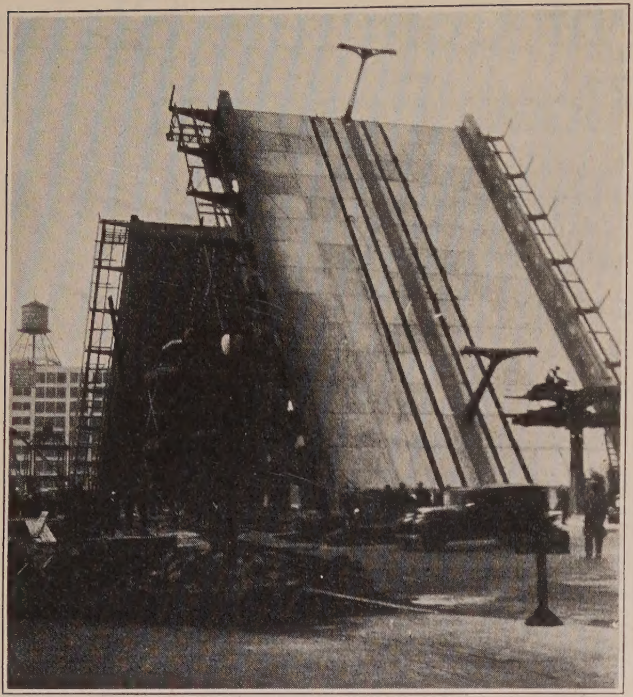
Age of specimen	Compressive Strength, Lb. per Sq. In.		
	Average	High	Low
8 Hrs. (cured 6 hrs. in steam at 100 deg. F.)	2511	2830	2173
1 day (4 groups of 6 specimens each)	4388	5239	2971
	3615	4067	2653
	2695	2830	2493
	3501	2784	4068
3 days (4 groups of 6 specimens each)	4287	5328	3713
	4442	5081	3658
	4508	5341	3109
	5109	5690	4245
7 days (4 groups of 6 specimens each)	4235	4656	3814
	5478	6296	4634
	5853	6573	5520
	4800	6084	3757
28 days (1 group of 6 specimens)	5170	5978	3833

1-day, 3-day, 7-day and 28-day specimens were not cured in steam.

Casting and Handling the Slabs

The slabs were cast at the Chicago plant of Benedict Stone, Inc., by the aid of an electric vibrating process that vibrated the steel reinforcement itself. The molds were in a horizontal position. All reinforcement was anchored firmly, so that even with men walking on it, the steel was less than an eighth of an inch out of position.

Four holes were provided in each slab into which 1-in. pipe sleeves were fitted to facilitate handling of the slabs. These sleeves were filled with mortar after the slabs were erected.



View of roadway slabs with bridge open. Sidewalk slabs not placed

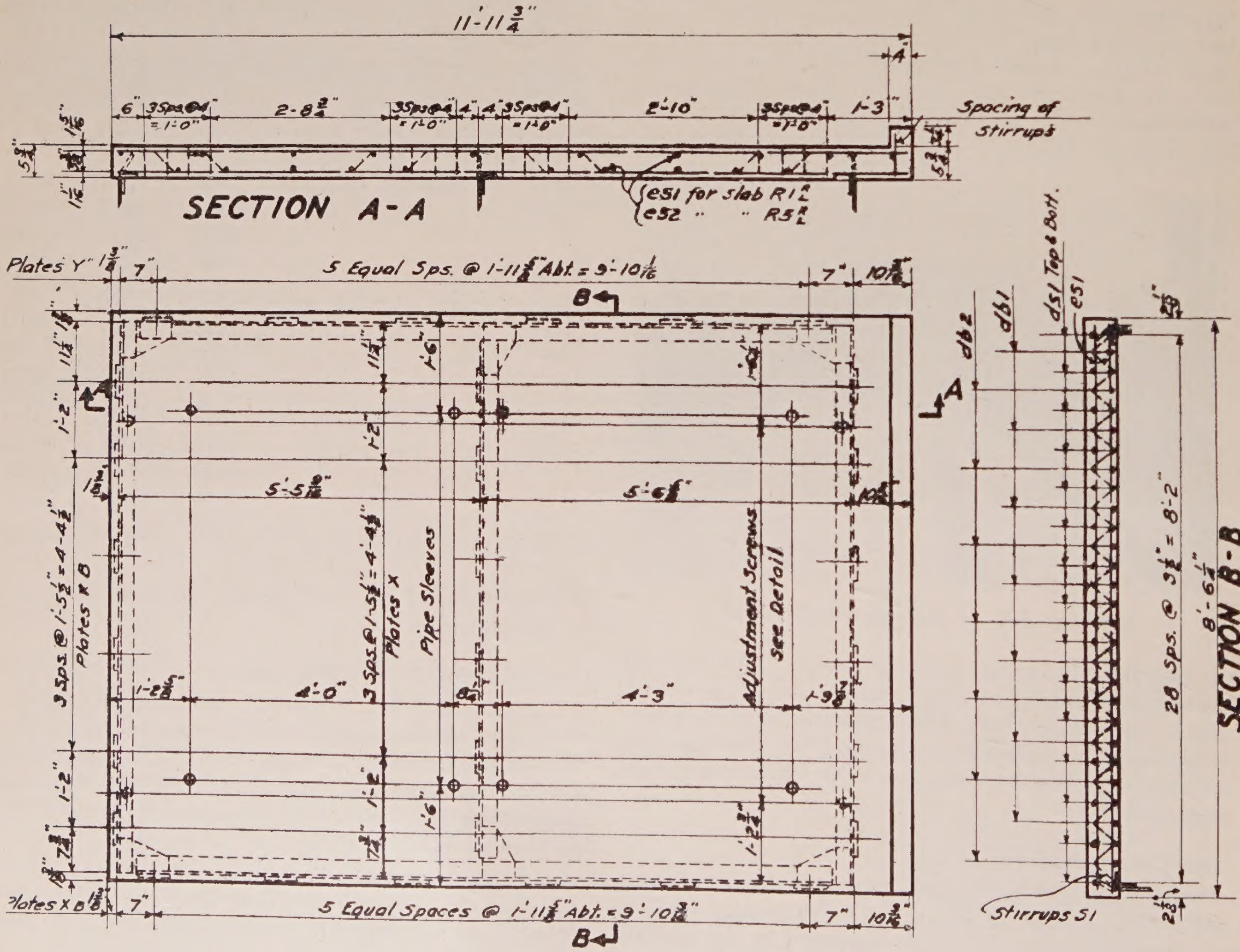
Further provision was made for anchoring each slab immediately after being placed, so that the slab would not slip from its position if the bridge had to be opened before the slab could be welded to the steel floor system. This was accomplished by U-bolts passing under the stringers and up through holes in the slabs where loose plates were held with nuts. The anchoring device was removed after the slabs were welded into place and the holes filled with mortar.

At the bridge the slabs were lifted into position by a steam derrick equipped with two sets of cable spreaders fitted with hooks on each end.

The final operation then consisted of welding the slabs to the steel floor system, by means of 3/8-in. protruding steel plates. One end of these plates was imbedded in the slab and riveted to a continuous steel angle, one leg of which was also imbedded. These details are shown to rather small scale in the drawing.

Development of City Bridge Division

As previously stated, this new type of bridge floor design and construction has been initiated and developed by the Division of Bridges of the Bureau of Engineering in the Department of Public Works, a department of the city government of Chicago. The work has been con-



Detail of largest roadway slab

ducted under the direction of Loran D. Gayton, city engineer and head of the Bureau of Engineering, and Major Paul Schioler, city bridge engineer and head of the Division of Bridges. The design and plans were prepared in the bridge designing section under Donald N. Becker, engineer of bridge design. An invitation is extended to bridge engineers to examine the complete plans in the Bridge Division office. Leon B. Kordell is resident engineer of construction on the work, representing the Division of Bridges. The Wabash Avenue bridge and its approaches are being built by the Ketler-Elliott Company, of Chicago.

Profitable Manufacture of Concrete Building Units

Writer Follows Analysis of Products Industry in Last Month's Issue by Second Article in Important Series—Tells How the Output is Estimated in Advance

II—Scheduling the Output

By **FRED A. SAGER**
Consulting Industrial Engineer

IN 1924 a Chicago concern doing a manufacturing business with twenty-five representatives located at district warehouses, scattered over the territory from Pittsburgh in the East to Seattle, San Francisco and Los Angeles in the West, came to a consulting engineering office in Chicago with a list of three or more complaints pertaining to their business.

A Typical Manufacturing Ailment

The district managers were dissatisfied because their orders for goods of specific types were delayed in delivery at their warehouse. The production department complained that too large a percentage of the production was for rush orders of various types of the product for this or that warehouse, and that as their production included several hundred items of many types, a systematic production schedule was, in fact, operative over a much smaller percentage of the plant output than should be the case. The business management was disturbed by the large demurrage charges on cars out-bound to the district warehouses, held for the rush order shipments requested by the district managers, the resulting congestion affecting also the in-bound shipments of raw materials. The management was also questioning the size of the inventory of finished goods carried, particularly in view of the fact that such large inventory did not relieve the trouble of the district managers in filling their sales orders.

The Diagnosis

In this matter the first thing done by the representatives of the engineering office was to examine the company's business for the three preceding years—that is, the total sales, segregated by types and sizes of the product and by district warehouses. It was soon apparent that of the several hundred items manufactured, from 80 to 90 per cent of the business was done in perhaps two dozen items. If these were scheduled for production and shipment to the twenty-five district warehouses, simple methods of handling the small balance of the product, comprising numerous items, could be arranged and the basic complaint could be eliminated.

Prescribing the Remedy

The plan in brief was this: From the records of the three preceding years, the sales requirements for the next year were estimated with considerable care for the two dozen major items, this estimate including the expected increase in volume of business. The number of carloads to be shipped per month to each warehouse was estimated and a schedule of dates of car shipments prepared. The frequency of deliveries to and estimated sales for each warehouse, the stocks necessary to be carried at each, and at the manufacturing plant, was determined. As to the large number of items moving in small quantities, minimum stocks for these items were worked out for each warehouse and schedules of from one to four shipments per year to each warehouse were worked out; and a uniform production schedule was prepared for the production department.

Furthermore, it was arranged that the district managers should be relieved of all care in the matter of stocks in their warehouses. Their duty in the matter was done when they sent in their regular daily sales reports. These reports were handled in the Chicago office by one man, who was in position to check up actual sales with the estimate previously made for each warehouse, and who was then able to determine whether the proposed shipments to the given warehouse should be increased or decreased from that estimated, to the end that each warehouse should be provided with suitable stock.

New Plan Is Successful

This plan was fully discussed with all the district managers at the January meeting in 1925 and their best estimate of the year's sales was obtained and taken into consideration in preparing the working program for the year

1925. They were all anxious to try any plan designed to provide them with the stocks they required to make proper deliveries of their sales, but most of them were very skeptical as to any plan that was designed to operate with little or none of their attention. The plan, however, has worked to the satisfaction of all concerned, is now in full operation in the Chicago company and has been made operative in an associated company operating in the East. The district managers, without any worry on their part, are provided with ample stock. They are only asked to report, to Chicago, any special sale that they may be arranging with a department store that may take a large number of one given type of item. The out-bound cars come into and leave the plant on a pre-arranged schedule, the irregularities due to unpredicted variations from the basic schedule being reduced to a negligible percentage. The production department is working on a definite and uniform schedule, the rush order or unscheduled production being very small. The total stocks carried in the Chicago plant and at the twenty-five warehouses was decreased by from 25 to 30 per cent, with the improved service to the district managers in that they have what they want when they want it.

Application to the Products Industry

The interest in this example to the products industry is this: the possibility of reducing stocks carried, by smoothing out the production curve with a fluctuating delivery curve, by a careful control of a few major items of the plant's product. This concentration of production in a few items is common to many lines of manufacture, although there are some lines to which it does not apply. It is worthwhile to determine whether or not it will apply.

As an application of this method to the products business, the output for one year, based on the actual experience of a plant, is given in the first four columns of Table 1, "Sales Per Year, Maximum Sales in One Month and Average Minimum Stocks, by Items of Production." The second column shows the number of the item in column one that were sold during the year. The third column converts the amounts in column two to a common base, "equivalent 8-inch units," i. e., an 8 by 12 by 16-inch block is taken as 1.5 equivalent 8-inch units, and the 8 by 4 by 16-inch block is taken as 0.5 equivalent 8-inch units. The equivalent unit here adopted is related more to quantity of materials required than to the combination of both material and labor required in the production of the block, but is sufficiently accurate for most purposes. A plant with a large output may well use a more exact equivalent basic unit.

Five Units Supply 90 Per Cent of Production

The fourth column shows the production in "equivalent units" for each item, expressed as a percentage of the total production, a casual observation of which indicates that the major production was in five items out of the sixteen listed. By including in Group A all items over 5 per cent of the total production, and in Group B all items under 5 per cent, we find 90.28 per cent of the production in the five items of Group A and 9.79 per cent in the eleven items of Group B. Now by a study of production and stock, so far as the five items of Group A are concerned,

TABLE 1

Sales Per Year, Maximum Sales in One Month and Average Minimum Stocks, by Items of Production

Type of Block and Size, Inches	Sales for Year					Maximum Sales, 1 Month		Average Minimum Stock	
	Number	Equiv. 8 In. Units	Per Cent	Group A	Group B	Number	Equiv. 8 In. Units	Number	Equiv. 8 In. Units
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8 Plain	141,495	141,495	50.45	141,495		29,559	29,559	25,000	25,000
10 Plain	13,977	17,441	6.22	17,441		4,125	5,156	4,000	5,000
12 Plain	28,914	43,371	15.44	43,371		9,501	14,251	10,000	15,000
8 Cor.	15,966	15,966	5.69	15,966		3,315	3,315	3,000	3,000
10 Cor.	1,044	1,305	.46		1,305	321	401	400	500
12 Cor.	1,827	2,740	.98		2,740	742	1,113	1,000	1,500
8 Half Cor.	13,023	6,512	2.32		6,512	2,883	1,442	2,000	2,000
10 Half Cor.	321	201	.07		201	150	94	400	250
12 Half Cor.	755	566	.20		566	300	225	1,000	750
8 Wood Jambs	1,857	1,857	.66		1,857	675	675	1,000	1,000
8 Hf. Wood Jambs	1,536	768	.27		768	678	389	1,000	500
8 Pier	306	306	.11		306	231	231	500	500
8 Half Pier	174	87	.03		87	120	60	500	250
4 Plain	69,993	34,996	12.48	34,996		13,746	6,873	15,000	7,500
4 Solid	9,855	7,884	2.81		7,884	2,688	2,150	2,000	1,600
Chimney	2,685	5,370	1.88		5,370	666	1,332	1,000	2,000
		280,865	100.00	253,269	27,596				66,350

the control of the major part of the output is accomplished and the items in Group B can be handled by a simple method as to stock carried and as a fill-in at convenient times, as to production.

Cured and Uncured Stock

In a concrete products plant stocks are carried for certain fundamental reasons. First, a certain time is required for the product to cure after it has left the machines or kilns. This is really part of the process of manufacture. The output of the plant for the preceding two or three weeks, that has been put in the stock-piles, is really still "in manufacture." Since, however, as a matter of general practice, this fresh product is counted as stock, allowance for this uncured product should be made in estimating the total stock to be carried. Second, cured stock, ready for delivery, must be carried to supply the day to day demand, which quantity of stock may be called the "average minimum" stock requirements, such stock being sufficient to take care of, in any month, the probable requirements for the month in any and all of the items produced. Third, additional stock at certain times of the year to permit of a more uniform rate of production. If the first two items are properly chosen and the proper rate of production established, the third item will take care of itself in general.

Amount of Cured Stock Required

The amount of cured stock to be carried may be determined from general consideration of the total amount of all types of product to be carried and by detailed consideration of the requirements of each type or item. It will be an unusual business that will not be satisfied if the total cured stock is maintained with an "average minimum" equal to the maximum month's sales of product. Naturally it is good business to operate with the least amount of capital tied up in stock, that will permit of prompt deliveries of all orders. Considerable experience in a given plant is necessary to get stocks to a minimum and retain 100 per cent service. At the start a safe margin should be carried and if later it is found that smaller stocks, properly handled, will suffice, the cuts in inventory can then be made.

How Minimum Stock Is Determined

The stock shown in the last two columns of Table 1 have been determined as follows: First, the total stock carried shall be equal to the maximum month's sales for the preceding year, or the estimated maximum month's sales for the coming year, if they are expected to vary materially from the proceeding year, to which is added one-half month's production. Second, the stocks for each of the major items, Group A, should be equal or nearly equal to the maximum month's sales of that item. The stock for the items in Group B should be carried on the average about one-half of an economical production quantity, say a day's run on that item or on that item and another item with similar machine set-up. For example, in the case of 8-inch piers and 8-inch half piers, the totals used for the year were 231 and 61, respectively. One day's run on these items would produce enough to last a couple years for the piers and longer for the half piers. And again it is possible that the total sales of last year may go out in one month in the next year. But in any case, if, when the stocks of items in Group B are low, a day's production is run in this item, such a plan of fill-in production for this group will keep the total for the group at an average figure all the time.

To apply this method of determining stock to be carried with the production shown in Table 1, it is necessary to have knowledge of the maximum delivery of product in any one month of the year, as set up in Table 2, which shows the deliveries of all items of product expressed in equivalent 8-inch units.

TABLE 2

Deliveries in Equivalent 8-Inch Units for the Year, by Months

January	40,899
February	9,984
March	21,644
April	25,971
May	32,302
June	45,180
July	9,018
August	53,343
September	8,271
October	10,470
November	12,339
December	11,444
Total	280,865

This total is seen to be the same as that of column three in Table 1. It is evident that the variation in monthly sales is great, and if similar range in the monthly sales is anticipated in the coming year, proper provision therefor should be made in the cured stock carried. For the purpose of this analysis it is assumed that the business of the succeeding year will be materially larger, and that for the most of the year the monthly production will be 30,000 equivalent 8-inch units.

Then the average minimum stock, in equivalent 8-inch units, should, on these premises, not be less than the sum of the maximum sales for August, or 53,343 units, plus at least one-half of one month's production, or 15,000 units, a total of 68,343 units. This general figure as to total stock should now be checked by a more detailed estimate of the stock required for each item. As a basis for this determination, the maximum month's sales for each item is set up as columns seven and eight in Table 1, column seven being the number of units sold and column eight being the equivalent in 8-inch units. For group A items, the assumed average minimum stock shown in column nine, is, in round numbers, the amount of the maximum monthly sales for that item. In the case of the first item (8-inch plain), with maximum sales of more than 29,000, the average sale per month was only 12,000, and the stock was set at 25,000, slightly less than the maximum month's sales. In the case of the 12-inch plain blocks, the stock of 10,000 was set higher than the maximum month's sales, on account of an estimated greater sale of this item during the coming year. Thus the stocks for Group A items, appearing in column nine, were chosen after consideration of past and estimated future business, and follow in general the last year's maximum month.

The stocks for Group B items were determined generally as about half of an economical run for the given item, except where the maximum month's sales (column seven) exceed this amount, in which case the larger amount determined the stock to be carried. The assumed average minimum stock for each item, thus derived, was converted into equivalent 8-inch units (column ten) and was found to total 66,350 units, which agrees closely enough with the general requirement of 68,343 units previously determined.

It is proposed, in the next article, to operate with this method on the succeeding year's business with an assumed uniform production rate, and see how it works out. If the next year has fluctuations as wide as that indicated in Table 2, and if the deliveries can be made with uniform production, the method must have some merit.

Short-Cuts in Structural Design

Simpler Methods Needed for Design of Reinforced Concrete — Coming Series of Short-Cuts Will Avoid Complicated Formulas and Derivations

By JAMES R. GRIFFITH
Professor of Structural Engineering,
Oregon State Agricultural College

CONCRETE announced three years ago this month (January, 1928) that I would present a series of charts devised to assist in the routine problems of reinforced concrete design. During those three years I have learned to sympathize with the cartoonist and columnist who must daily worry about deadlines. I have seen my "brain child," as the Editor has called it, grow to precocious youth. I must confess I had but an idea with which to start, and a hobby for the construction of charts.

Simple Designing Methods Needed

I. Oesterblom took a jab at the "teaching profession" on page 769 of the May, 1930, *Journal* of the American Concrete Institute. So perhaps I have said too much. But then on page 774 of the same publication he pays the past series in CONCRETE a definite and fully appreciated compliment. I am inclined to agree that the simple facts are frequently hidden by the smoke of academic derivations and discussion. But I am not so sure that the teaching profession is alone responsible. In fact I could refer to some contributions by the practicing profession which would shame the most academic discussion of a college professor. I have honestly tried to dispel the smoke. If I have failed, I will gladly turn the job over to anyone else who may think he can do better.

The Old and New Series

Upon completion of the first eighteen articles and charts, which have since been reprinted and sold out, I would gladly have written the journalistic "30" indicating the end. But it was to be otherwise. That series was followed by 20 additional charts, and the combined series of 38 charts has now been reprinted. Then a few months ago, at a conference with the staff of CONCRETE, I again pleaded press of other work. I was tired of seeing my "stuff." Surely the readers were likewise tired of it. However, we compromised on a series of "Short-Cuts in Structural Design," to appear in 1931.

I have been accused of encouraging the so-called "handbook engineer." I agree that charts are dangerous in the hands of the unskilled. So are automobiles and machine guns. I always will maintain that the user of any short-cut should first learn his theory thoroughly.

Varied Problems

In the first series of charts I tried to maintain continuity in both subject matter and chart types. In the coming series, I shall do neither. The problems will be varied and the charts constructed of the type best fitted for the problem.

Unbalanced Reinforcement

Balanced reinforcing, wherein both concrete and steel are stressed to their maximum, is no doubt the ideal condition. But again the ideal is seldom found in practice. When the balanced section is not strong enough for the bending moment, steel may be added. Likewise, when the balanced section is too strong, steel may be taken away. In the previous series I have demonstrated the method whereby the section may be strengthened by the addition of compression and tensile steel. In the February issue I will show how the area of steel may be reduced when the external bending moment is less than the resisting moment of the balanced section.

Foundation Walls and Footings

I have had numerous inquiries on the solution of foundation walls and footings. The principal difficulty in these problems is to obtain the loading. Once the loading is obtained the problem is but another beam or slab. The remaining articles to be presented will discuss the treatment of these problems.

Then I must inject a little human interest in the story. In a future issue I shall tramp on someone's toes, for verily he hath stolen my thunder. But fortunately I have the proof and shall submit the evidence.

Speedy Erection of Structural Frame Proves Value of Inspection

Rate is Two and One-Half Days Per Story—Architect, Owner and Contractor Co-Operate—Obtain Concrete of High Quality—Concrete Building Costs Less Than Steel Frame Design

By **B. L. MEHANDRU**
Engineer, John Nelson Company, General Contractors
South Bend, Indiana

THE construction of the Hoffman Hotel, South Bend, Indiana, during the midsummer of 1930, has demonstrated that co-operative effort between the architect, the owner and the contractor will benefit all interests concerned.

Costs Less than Steel Frame Building

The building is a 12-story structure, with reinforced concrete structural frame and floors. The floor is of pan construction, with a 3-in. slab and with 5-in. joists spaced 23 in. center to center. The total depth of the structural part of the floor is 8 in. Alternate plans for a structural steel frame, submitted by a structural steel company, failed to meet the costs of the reinforced concrete frame, in spite of the fact that the engineer for the financing company had required the inclusion of more reinforcement than called for by present design practice. The building is 83 by 69 ft. in plan and required 3,500 cu. yd. of concrete.

Independent Inspection Service

The medium through which the degree of co-operation was made possible was the inspection service supplied by the Robert W. Hunt Company, of Chicago.

While the general contractor was required to pay for this service, we considered it a good investment rather than an expense. It is doubtful that this involved any actual expense to the contractor, when the advantages are balanced against the actual cost of the service.

Where Inspection Service Saved Money

To begin with, there is little doubt that both the architect and the owner had greater confidence in the quality of the concrete work because of the inspection service.

As to actual savings, we were able, because of the constant check-up with tests, to save on cement. Our knowledge of the high early strengths being attained enabled the work to be speeded up, so that we saved on form material and labor through more frequent re-use of the forms.

There was a further saving on time, the importance of which not all contractors appreciate. On a construction job of this size the fixed expenses are likely to be from $2,000 to $2,500 per month, for items such as the salaries of the construction superintendent, the foremen, the mechanic and the time clerk, and for the wear and tear on mixing plant equipment. In consequence, the saving of even one month in the required time of construction is well worth while.

Handling and Storage of Materials

Little room was available for the storage of materials, a fact which may be judged from the illustrations, showing the congested downtown location. Space was available for the concrete mixing plant and for piling limited quantities of sand and gravel. We started by using premixed aggregates, but this was stopped after the foundations and the first floor concrete had been placed, because the materials had to be dumped in piles near the mixer and rehandled with wheelbarrows to the skip of the mixer. Consequently nothing was gained by the use of premixed aggregates. Cement was delivered as needed.

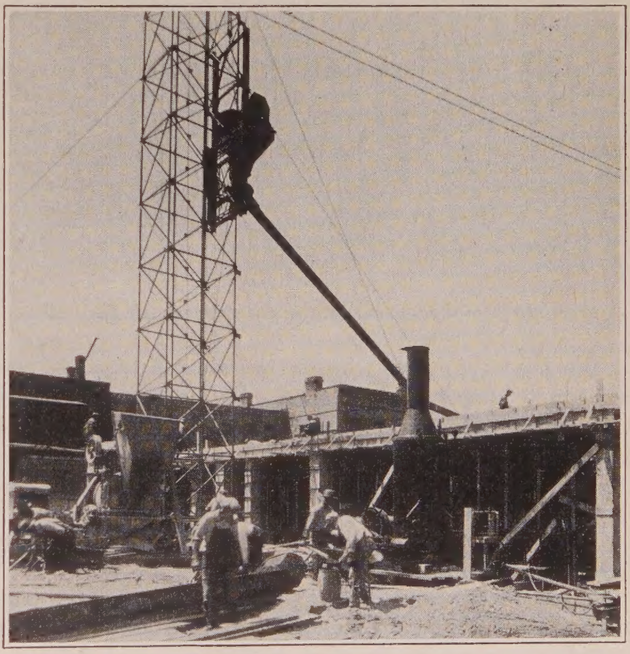


Figure 1. Concrete mixing plant, showing hoisting tower and tubular distributing chute

Concrete Mixing Plant

The concrete mixing plant, illustrated in Figure 1, was at the rear of the building. It was designed with an eye to the limited quantity to be mixed—namely, 3,500 cu. yd.

The capacity of the Lakewood mixer employed was ½ cu. yd., and actually we mixed concrete in 2-sack batches which yielded an average of 11.3 cu. yd. The mixer was equipped with a timing control that insured proper length of mixing. A water tank controlled the quantity of mixing water for each charge.

The hoist was operated by a boiler, shown in Figure 1, which was heated by city gas. To use this gas without excessive waste of heat we lined up the firebox with firebrick. Two jets of gas were directed into the firebox, so connected that when one jet was not sufficient to supply the steam needed, it automatically turned on the other jet.

Distribution of Concrete

The light steel frame hoisting tower and the tubular Archer distributing chute are clearly illustrated in Figure 1. This chute, supplied with the necessary extensions, was sufficient to distribute the concrete direct from the tower to the place of deposit. Buggies were required for concreting the top floor and the roof slab only, because the hoisting tower was not high enough to permit full employment of the tubular chute.

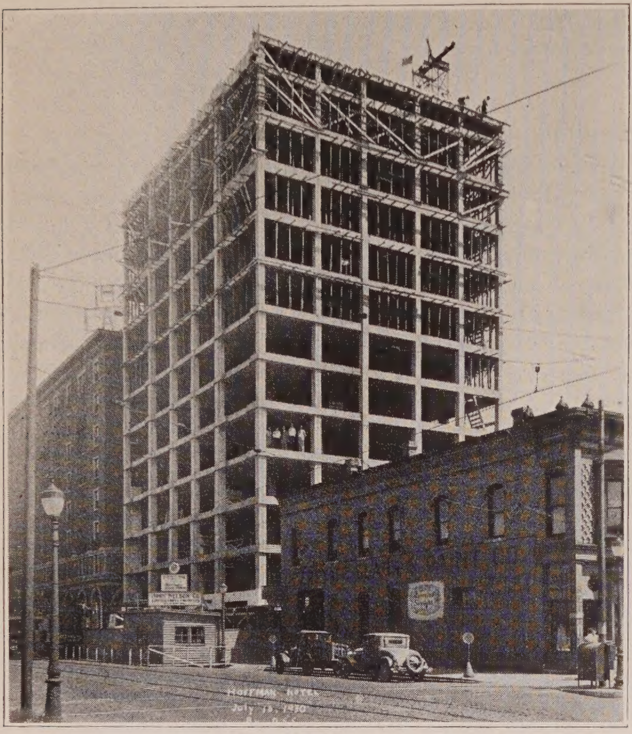


Figure 2. The structural frame completed, on July 18th

Proportions and Yield

The architect's specifications called for 2,000-lb. concrete in floors, while for columns the requirement was for 3,000-lb. concrete in the first five stories and 2,500-lb. concrete above the fifth story. Since a strength of 2,500 lb. per sq. in. at the age of 28 days was readily attainable with the standard portland cement employed, we designed both floor and column concrete above the fifth floor for a 28-day strength of 2,500 lb. per sq. in.

The proportions selected yielded 5.65 cu. ft. of concrete in place, per sack of cement, or 11.3 cu. ft. for each 2-sack batch. The water-cement ratio was $7\frac{3}{4}$ gallons of water to the sack of cement. The slump averaged $7\frac{1}{2}$ in.

Test Results

Complete field testing equipment, including molds, was used on the job. All cylinders were shipped to Chicago and tested at the Hunt laboratories.

The cylinders intended for the 7-day test were cured at the job for 4 days, under job conditions, then shipped to the laboratory and tested without further curing. The 28-day cylinders were similarly cured at the job for 4 days, then shipped to the laboratory and cured further in a laboratory moist room under water vapor curing conditions. The specimens were left in the moist room until they were tested. The following test results were obtained:

Age of specimens	Compressive strength, lb. per sq. in. Average	High	Low
7 days	1790	2122	1273
28 days	2785	3219	2476

As stated previously, ordinary standard portland cement was used, and the 7-day strengths attained were well above working strength requirements. There was greater variation in the 7-day strengths than in the 28-day results. Apparently this was due to the more variable conditions under which the 7-day cylinders were cured.

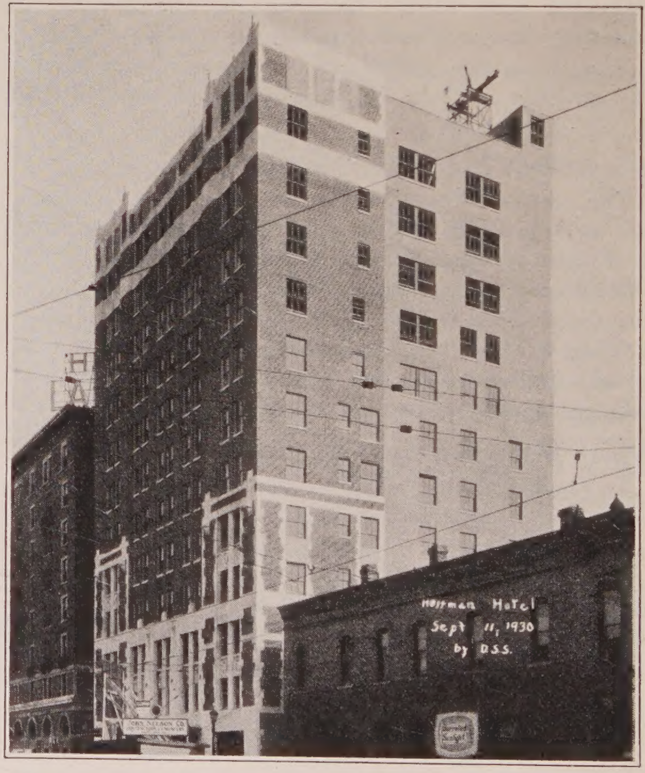


Figure 3. The building nearly completed as it appeared on September 11th

The Construction Schedule Beaten

Although concreting operations were started under a handicap of 9 days behind schedule, the roof slab was concreted 9 days ahead of schedule. The original delay had been caused by a break-down of the excavating shovel, as a result of which the foundation concreting was started on May 17th, 9 days late. The concreting work made ordinary progress in the first and second floor construction, the second floor having been concreted on June 5th. The third floor concrete was placed on June 11th. From that time forward a floor was concreted every Tuesday and Friday, until the twelfth floor was placed on July 12th. The roof slab was concreted on July 18th, 9 days ahead of the schedule. The run from the third to the twelfth floor was equivalent to one story every $2\frac{1}{2}$ days, since the union carpenters operated on a 5-day week.

The comparison between the progress schedule established and the actual progress made may be seen in the following tabulation:

Part of structure	Date set on schedule	Actual date of concreting
Foundation concreting started	May 8	May 17
First floor slab placed	May 27	May 29
Second floor slab	June 2	June 5
Third floor slab	June 6	June 11
Fourth floor slab	June 11	June 17
Fifth floor slab	June 16	June 20
Sixth floor slab	June 20	June 24
Seventh floor slab	June 26	June 27
Eighth floor slab	July 1	July 1
Ninth floor slab	July 3	July 3
Tenth floor slab	July 11	July 8
Eleventh floor slab	July 16	July 11
Twelfth floor slab	July 21	July 15
Roof slab	July 27	July 18

The actual schedule maintained from the third to the twelfth floors, inclusive, left only 1½ days for moving and framing the form work for a floor. The time required for concreting a floor was 8 hours. Accordingly, the period from Monday morning to Tuesday noon was occupied in getting ready for the Tuesday concreting (afternoon and evening). Wednesday and Thursday were then available to get ready for the Friday concreting.

The architect of the Hoffman Hotel was Willard M. Ellwood, of South Bend, and the general contractor was the John Nelson Company, of the same city. J. V. Quinn was resident engineer for the Robert W. Hunt Company and Roy Worden was the architect's superintendent. V. J. Reed was the superintendent of construction and the writer was the engineer for the general contractor.

Highway Research Board Discusses Maintenance and Construction

Raising Settled Concrete Slabs, Effect of Various Curing Agents, New Apparatus for Freezing and Thawing Tests, Are Among Important Subjects Considered

Papers and discussions of outstanding importance in highway construction and maintenance were presented at a meeting of the Highway Research Board held in Washington, D. C., on December 11 and 12.

Raising Settled Slabs With Force Pump

One of the papers that attracted much attention was presented by W. H. Root, of the Iowa State Highway Department, in which he described the method developed by John Poulter for the raising and leveling of settled concrete road slabs. This method, which involves the pumping of a thinned mixture of cement, loam and water through holes drilled into the settled slab, is described in an article printed elsewhere in this issue. A 20-h.p. gasoline-driven force pump is used for the purpose. During the summer of 1930 the department had five of these pumps working, and raised the equivalent of about 2 miles of 18-ft. slabs.

Quality of Aggregates

Several papers were presented on the subject of aggregates for concrete in highway construction. One of these, by Stanton Walker, director of the engineering and research division of the National Sand and Gravel Association, described tests on the effect of flat and elongated particles in coarse aggregates. His conclusions are that such particles have no harmful effects on the concrete if the particles themselves are of sound quality. In the specimens tested the quantity of flat and elongated particles ranged from 10 to 15 per cent of the total.

Apparatus for Freezing and Thawing Tests

Prof. C. H. Scholer, of Kansas State Agricultural College, described a highly successful apparatus for conducting freezing and thawing tests, either of concrete or concrete aggregates. It consists of a refrigerator so constructed and arranged that three cycles of freezing and thawing may be obtained in 24 hours. With this apparatus, Prof. Scholer reports, poorly made concrete has been completely disintegrated in 20 cycles, while some good mortars have scarcely been damaged in 1,500 cycles. Unsound aggregates can readily be detected either separately or in concrete.

Curing Methods

Much attention was given to papers and discussions on curing methods. Among the papers on this subject was a progress report by F. C. Lang, of the Minnesota State Highway Department, and Fred Burggraf, of the Highway Research Board, covering a survey of about 2,000 miles of concrete roads cured by various methods. The pavements included in the survey are located in five states and range from 4 to 7 years in age. Wet earth, calcium chloride applied either to the surface or integrally, sodium silicate, and bituminous surface coatings were the curing agents examined. Volume and temperature changes were found to be greater in bituminous-coated slabs than in others, but were reduced by covering the coating as soon as possible by whitewash or other light-colored material. The effect of this greater shrinkage and expansion in bituminous-coated slabs was minimized by the use of transverse joints, and was, in fact, not considered to be a serious matter or a factor of major importance in considering the use of this curing agent.

Co-Operation With A. R. B. A.

An agreement has been reached whereby the Highway Research Board will co-operate more closely with the American Road Builders Association, through the appointment of a joint committee of the two organizations, to deal with matters pertaining to road-building equipment.

Crushed Stone, Sand and Gravel Groups to Meet at St. Louis

The fourteenth annual convention of the National Crushed Stone Association will meet at the Hotel Jefferson, St. Louis, Mo., from January 19 to 22. The association invites all crushed stone producers of the United States and Canada to attend and participate.

The National Sand and Gravel Association will hold its fifteenth annual convention and exhibit of machinery and equipment from January 27 to the 29th, also at the Hotel Jefferson.

Heated Water Supplies Warmth During Moderately Cold Weather

Formula to Compute Probable Temperature of Mixed Concrete—Setting Cement Generates Much Heat—Insulation Suggested in Place of Artificial Heat

By A. C. IRWIN
Manager, Railways Bureau, Portland Cement Association

THE simplest and least expensive way to supply heat in a mass of fresh concrete to provide for moderate freezing temperatures is to heat the mixing water.

In order to get some idea of the theoretical limitations of heating the water only, in cold weather work, the following discussion is offered.

The specific heat of water is about four times the specific heat of the solid material entering into a concrete mix. It is obvious, therefore, that if we assume no heat lost, we can compute the resulting temperature of the fresh concrete if we know the initial temperature of all of the materials and the specific heat of the solids in the mix. Thus, let—

w = the weight of water
w' = the weight of solid material (as cement, sand and stone)
t = temperature of water
t' = temperature of solid material
x = temperature of mass after addition of water and mixing.

The specific heat of water is 1 and the specific heat of the sand, stone and cement may be taken as 0.22. We then have—

$$x = \frac{wt + 0.22\,w'\,t'}{w + 0.22\,w'}$$

As stated, x is the probable temperature of the mixed concrete. As an example, let—

w = 6 gallons = 50 lbs. of water
w' = 600 lbs. of aggregate plus 94 lbs. (1 sack) of cement
t = 180 deg. F.
t' = 35 deg. F.

By substitution in the above formula—
x = 71 deg. F.

Of course, heat will be lost in considerable quantity, depending on the insulation provided by the protective measures employed, the ratio of surface to volume of the mass and the difference between the temperature of the air and the temperature of the concrete. If we assume a 20 per cent loss of heat before the hardening process gets well under way, the mass would still have a temperature of about 55 degrees.

Heat Generated in Hardening Process

It is a well known fact that heat is evolved in the process of hardening of cement. If no heat were lost, this evolved heat would raise the temperature of the concrete to a surprising degree. Thus, in the above example the specific heat of the concrete (including the water) would be about 0.27 and the total weight 744 lbs. In order to raise the temperature of the concrete one degree, there would be required 744 × 0.27 = 201 B.t.u.'s, and if no heat were lost the temperature of the mass would be raised an amount equal to the B.t.u.'s liberated by the hardening process, divided by 201. This added to the temperature of the concrete at the beginning of the hardening would raise the temperature decidedly, and would probably reach over 100 deg. F. about 50 hours after placement, providing no heat were lost.

Insulating Material Instead of Artificial Heat

The above indicates the rather surprising effect of heating water combined with the evolution of heat in the process of hardening of cement. It shows the possibilities of substituting insulating material as a protection to fresh concrete in winter construction as against supplying heat artificially. Insulation would have an additional advantage in that there would be no tendency to dry out the concrete and would for that reason provide excellent curing conditions. It would be possible to compute approximately the temperature of the concrete at any given time if the rate of release of heat together with the coefficient of heat loss of the insulating material could be known. Coefficients of heat loss of various insulating materials are fairly well known and weather forecasts could be used as a guide to outside temperatures. The rate of generation of heat depends, of course, on the rapidity of the hardening process, and this in turn upon the temperature and moisture content.

Limitations of Formula

The formula is approximately correct for aggregates that are not frozen or do not contain ice and when no heat is lost. It is not applicable to the condition where the heat in the water must thaw out frozen aggregate as well as raise its temperature. In general, aggregate should be thoroughly thawed out before it is introduced into a concrete mixer.

Highway Planning

Every foot of travel distance saved on a highway will justify an expenditure of $60 to eliminate that foot, calculations by Professor T. R. Agg, of Iowa State College show, provided the highway carries 1,000 tons of vehicles a day.

~ EDITORIAL ~

Highway Construction Becomes More Complex

NEW concrete highways for which contracts were awarded in 1930, will add the equivalent of 10,200 miles of 18-ft. pavements to the nation's system of paved roads. Concrete street and alley contracts are the equivalent of a 30-ft. street more than 2,000 miles long.

The totals for 1930 are about 108,000,000 sq. yd. of concrete roads, and about 36,000,000 sq. yd. of concrete streets and alleys. The road yardage exceeds the highest previous record by 15,000,000; the street and alley pavement yardage fell below the previous year, but the total yardage of 144,000,000 tops all previous yearly accomplishments.

This vast quantity of construction work has given direct employment to more than 300,000 workmen. It has kept the personnel of federal bureaus and state and county highway departments on their toes. But it has done even more, for it has proved that the effect of a major business depression can be softened by speeding up on needed public work.

The year just closed has ventured far into the more complex ramifications of highway development. No longer is highway progress a mere matter of more mileage or more millions of square yards. We have entered into the more difficult phases of untangling congested traffic. Intersections between main highways, and between highways and railways, are being eliminated by grade separation structures. Bottlenecks are being removed. Main highways in metropolitan areas are being widened. Parallel roads are being built to relieve main traffic arteries. Four-lane superhighways are being built between cities.

Coincidental with the construction of superhighways we see the growth of a new idea at the other extreme—the construction of secondary, single-lane concrete roads to bring outlying rural sections into contact with their markets.

While 1930 has seen no great new development in highway construction methods or equipment, there has been a wider application of both. Thirty-two states—six more than a year ago—now require machine finishing for concrete roads. Positive control of the quality of concrete is now required in a greater number of states than a year ago. More reliable equipment is being developed for the maintenance of quality control. The relative values of different curing methods are known more definitely than in former years.

Highway construction has, in truth, developed into a modern romance, one in which scientific facts and theories are put to very practical uses. It promises still greater things, for the future development of highways will demand the attention of the highest order of engineering knowledge and experience.

The Growth of a Fool Idea

IN the fall of 1929 a man out in Mount Pleasant, Iowa, had a fool idea.

The concrete floor in his garage had settled badly at a place where the subgrade was soft. He hatched out the idea that if he could force some mud under the settled floor he could force it back to the proper level. He tried the experiment by drilling a few holes down through the floor slab. Then he set a short piece of pipe in the hole and placed a funnel into the top of the pipe; and with a broomstick he pounded some near-liquid mud through the holes and under the slab. It worked.

Last winter he rigged up a makeshift force pump and tried it out on heavier slabs. Again it worked.

Next he thought of the many places where concrete highway slabs, built over marshy ground or on fills that were too soft, had warped and settled. After protecting himself with patents he assembled a larger force pump with which he was successful in lifting and leveling settled road slabs. All through the rest of 1930 this machine and several additional ones were kept busy by the state highway department, raising and leveling settled concrete slabs.

In the meantime more of these pumps are being made, to reclaim warped concrete highway slabs on unstable subgrades. And it all came to pass because this man saw through something that had all the earmarks of a fool idea.

Further Hesitation Will Be Costly

BUSINESS must shortly resume its normal upward swing, the head of a large construction company writes us, and in his opinion the opportunity to let new building contracts at the present low price levels will not long remain with us.

Not since 1922, he says, has his company constructed buildings at the low unit price levels of 1930. The moment it becomes clear that business is improving, present unit prices will be withdrawn and the cost of building will increase.

This opinion comes from a man who knows. For more than a quarter of a century his company has made a specialty of erecting reinforced concrete buildings for office and industrial occupancies. He has passed through several periods much like the present one.

Architects and engineers will do well to advise their clients that this is a time for action. Further hesitation will be costly.

PROGRESS—In a Page

Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups.

Committee C-1 on Cement Widens Out Its Program

THE American Society for Testing Materials Committee C-1 on Cement has effected a reorganization and prepared a preliminary plan of work for the coming two years. With this reorganization the committee will be in a better position to carry on more fundamental and detailed studies of the two most widely used hydraulic cements—high-early-strength portland cement and portland cement, specifications for both of which have been adopted by the society—and of the masonry and plastic cements, whose use is growing rapidly.

The outstanding feature of the new plan of committee operation places the investigations and the preparation of a standard of each type of cement under a separate subcommittee. For the present, therefore, there will be a subcommittee on standard portland cement, one on masonry cement, and one on all high-early-strength cements, both of the portland and high-alumina types. Another subcommittee will have the duty of preparing standard methods of test. This subcommittee will help the other subcommittees develop and refine the methods they think are needed to indicate the desired requirements, and further make as uniform and co-ordinated as possible the testing methods for all hydraulic cements.

Plans for future work are to make extensive studies of the new test methods suggested by progressive users and producers.

The committee will welcome at all times, and especially now when the subcommittees are developing new programs of investigational work, suggestions from all those interested in the testing and using of cement. The committee would be very glad to have comments as to the types of tests which should be studied, data indicating the adequacy or inadequacy of present methods, suggestions as to specific requirements, and in fact anything that an interested party would consider of value to the committee.

The secretary of Committee C-1 on Cement is F. H. Jackson, of the U. S. Bureau of Public Roads, Washington, D. C.

Concrete Burial Vault Specifications

A COMMITTEE of the National Concrete Burial Vault Association (J. H. Stuart, secretary, Bremen, Ohio) has prepared a tentative specification for the manufacture of precast concrete burial vaults.

The committee is now co-operating with the American Concrete Institute and the Portland Cement Association toward the development of a standard specification which is expected to be completed early in 1931.

The tentative specification previously drafted by the N. C. B. V. A. committee contains the following requirements, among others:

(1) The 28-day compressive strength of the concrete used shall be not less than 4,000 lb. per sq. in. The strength of the concrete shall be fixed in terms of the water-cement ratio.

(2) A water-cement ratio of not more than 4¾ gallons of water to the sack of cement is recommended.

(3) Suggested proportions (as a basis to start with) are 1 part of cement, 1½ parts of sand, and 2 parts of pebbles passing a ½-in. sieve.

(4) The concrete shall be mixed for at least 5 minutes after all the ingredients are in the mixer.

(5) The concrete shall be thoroughly compacted by puddling, and moist-cured for at least 7 days.

(6) Metal reinforcement shall be accurately placed in the center of the wall, and the cross-sectional area of the reinforcement shall not exceed 1 per cent of the cross-sectional area of the concrete.

A. S. T. M. Committee C-9 Working on Many Projects

COMMITTEE C-9 on Concrete and Concrete Aggregates, of the American Society for Testing Materials, has an unusual number of studies and investigations under way. Following is a list of subjects now occupying the committee's attention:

Design of Concrete.
Studies of Concrete Aggregates.
Deleterious Substances in Concrete.
Curing of Concrete.
Workability of Concrete.
Admixtures in Concrete.
Elastic Properties of Concrete.
Conditions Affecting Durability of Concrete in Structures.

In addition, this committee is co-operating with other A. S. T. M. committees in a study of "Weathering Characteristics of Masonry Materials." Stanton Walker, director of the engineering and research division of the National Sand and Gravel Association, 545 Munsey Building, Washington, D. C., is secretary of Committee C-9.

Three New Publications on Sand and Gravel Available

THREE new publications dealing with certain scientific aspects of sand and gravel were issued in October and November as Circulars 6, 7, and 8 by the National Sand and Gravel Association, 545 Munsey Building, Washington, D. C. The titles of the new publications are:

Circular 6—Effect of Soft Particles of Coarse Aggregate on Strength and Durability of Concrete; by W. J. Emmons.

Circular 7—Effect of Addition of Finer Sizes of Gravel on Strength of Concrete; by Stanton Walker.

Circular 8—Effect of Grading of Gravel and Sand on Voids and Weights; by Stanton Walker.

Mr. Emmons is director of the Michigan State Highway Department laboratory, and Mr. Walker is director of the engineering and research division of the National Sand and Gravel Association.

Copies of these new publications may be obtained, without charge, from the National Sand and Gravel Association.

Settled Concrete Road Slabs Lifted and Leveled by Force Pump

Mixture of Cement, Mud and Water Forced Through Holes Drilled Through Slab—In Successful Use on Iowa Roads

IN Iowa, settled concrete pavement slabs are being raised and leveled up by pumping a mixture of loam, cement and water under them.

The method was developed by John Poulter, of Mount Pleasant, Iowa, formerly with the Iowa State Highway Department. He had a concrete garage floor that needed leveling. He drilled small holes through the floor, inserted a piece of pipe into one hole at a time, placed a funnel into the top of the pipe, and with the end of a broomstick he forced some near-liquid mud through the holes and under the slab. Slowly he lifted the settled part of the floor to its proper level. That was late in the fall of 1929. During the winter he rigged up a makeshift force pump and tried the method on some uneven floors, with success, and as a result an improved pump was assembled and tried on settled highway slabs in the spring of 1930.

Mixture of Cement and Mud

Originally, the mixture forced under the slab was just thin mud, preferably made with black loam, as that was found to work best. Later, one sack of cement was added for each cubic yard of loam because it was found that the cement made the mixture stiffen more rapidly and reduced shrinkage from about 4/10-inch in 6 inches of the plain mud to 1/10-inch in 6 inches of the mud-cement mixture. The mixture hardens in 10 or 12 hours until it is as firm as the other material in the subgrade.

Forced Through Holes in Slab

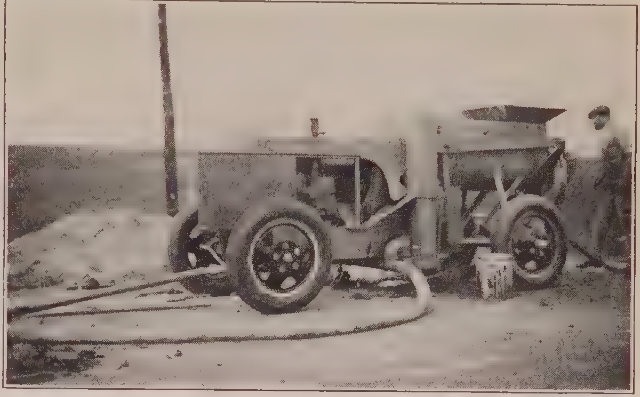
The pump now in use has a chamber in which loam, water and cement are mixed. The mixture is forced through a 2-inch hose. Holes slightly smaller than the outside diameter of the hose are bored in the settled pavement on about 6-foot centers. The hose is forced into one of the holes and the pump is started. The swelling of the hose with the pressure of the mixture holds the end fast in the hole. If the pressure is too great the end of the hose will fly out, thus acting as a safety valve. The pressure is low, seldom over 5 pounds per square inch, and usually less.

Road Slabs Raised 16 Inches

Slabs which have settled as much as 16 inches have been successfully raised by this method. These are brought up slowly, ½-inch or so from each hole, to avoid cracking. The hose is shifted from hole to hole, as judgment dictates. There has been no cracking of slabs where care was used. Slabs already cracked are also readily raised. By grouting at the proper hole the slabs may be leveled or tilted as desired.

Where the pavement has settled considerably, with a settling fill, a large quantity of the mixture must be pumped under the slab before it begins to lift because there are cavities under the pavement which must be filled.

The pressure is seldom sufficient to force the mixture through the earth shoulder in a "blowout." When that occurs the places are easily plugged with a sack or plank or by pounding dirt into the opening.



Method of lifting and leveling concrete road slabs, as developed in Iowa

Roads Kept Open to Traffic

It is not necessary to detour traffic while a slab is being raised, as only half the pavement is lifted at a time. Even 18-foot slabs with no center joint are lifted half-at-a-time.

The crew used in raising slabs consists of 6 or 8 men, including those hauling the black dirt, which is usually obtained in the vicinity. The grouting machine is furnished at a rental of $2.00 per hour. The total cost, including rental on machine, drilling holes, cement, water, and incidentals, has averaged between $7 and $8 per cu. yd. for the material placed under the slab.

The pump and method of lifting slabs are patented, and the pump has been placed on the market.

Transit-Mixed Concrete Makers Convene Before Road Show

The National Association of Paris Transit Mixed Concrete Manufacturers will hold its annual convention at the Marquette Hotel, St. Louis, Mo., January 9th to 12th, preceding the annual road show in the same city.

Representatives of the National Sand and Gravel and the Portland Cement associations will address the convention. Development of this industry during the past year and the methods of manufacturing and delivering transit-mixed concrete will be shown by moving pictures.

Some Features of the Road Builders' Association Program

The opening of the American Road Builders' Association convention is scheduled to take place on the morning of Monday, January 12th, with an address of welcome by Mayor Victor J. Miller of St. Louis. The opening of the exposition will follow an hour later.

The first county highway officials' session will begin at 2:00 p. m. and among the papers to be presented is one on "Financing and Planning Secondary Highway Systems" by the County Legislation and Finance Committee. This report will combine the subjects of that committee with those of the committee on regional surveys and plans.

At the same time a joint session on steel forms and weighing devices will hear the reports of committees on these subjects. P. M. Tebbs is chairman of the committee on standardization of weighing devices for concrete aggregates and will present specifications for such equipment on small mixers for bridge work and like structures, similar to the specifications developed by the association for the bin batcher type of equipment and central mixing plants.

A survey of the steel form field was made by the Committee on Standardization of Steel Forms for Concrete Pavements, and the report prepared was presented to the American Association of State Highway Officials at its 1930 convention. The recommendations of the latter are included in the final report to be presented before the Road Builders.

The exposition will reopen at 9 a. m. on Tuesday, January 13. One of the first reports of the day to come before the convention will be that of the committee on highway location, of which R. Getty Browning is chairman. Another report is that embodying a resume of problems facing the committee on airport drainage and surfacing.

One of the subjects to be brought before the contractors' session, also at 10:00 a. m., by the committee on maintenance, is the reduction and correction of failures, resurfacing and salvaging of existing pavements, and the utilization of old bases.

The report of the Committee on Design and Construction, scheduled for presentation at the City Officials' session at 2 p.m., will cover its extended studies on pavement wearing surfaces to determine the best methods of design and construction, street railway paving, and contracts and specifications to determine points of similarity and desirability for purposes of standardization.

One of the early reports scheduled for the January 14th session is that of the Committee on Subgrades and Pavement Bases, presenting data and details recommending methods of best design practice for the construction of city streets.

The afternoon program of the County Officials' section will include a report reviewing the progress in widening and reconstructing, emphasizing particularly the newer features in research, design and construction.

One of the features of the last day's session will be the Central and Truck-Mixed Concrete committee report, prepared under the chairmanship of R. Keith Compton, comprising complete, authoritative information for the engineer who is called upon to decide the advisability of using ready-mixed concrete on highway work.

D. R. Collins Joins Consolidated Concrete Machinery Corporation

D. R. Collins, who has been closely connected with the concrete products industry since 1919, has joined the staff of the Consolidated Concrete Machinery Corporation at Adrian, Mich., as sales promotion manager.

Mr. Collins' long career in this industry has given him an unusually wide personal acquaintance among manufacturers of concrete products. During the rapid growth of the industry, in the years following the war, he was on the staff of the cement products bureau of the Portland Cement Association. During this period he traveled into all parts of the United States and Canada, visiting products plants and studying their problems in the light of local conditions.

Later, as manager for one of the large products manufacturing plants in Milwaukee, Mr. Collins obtained first-hand acquaintance with the manufacture and sale of concrete products. This was in the period from 1925 to 1929, when concrete products were making definite strides toward getting into large buildings, particularly as back-up and partition units in structures such as apartment buildings, hotels and office buildings. In 1929 he became manager of a co-operative association for marketing concrete products in Milwaukee city and county.

Mr. Collins has long taken an active interest in associations of products manufacturers, having been instrumental in organizing the Wisconsin Concrete Products Association and the National Concrete Products Association. When the national organization was replaced, early in 1930, by the Concrete Masonry Association, he became the first president of the latter association.

Coming Conventions

January 9-12—National Association of Paris Transit Mixed Concrete Manufacturers, annual convention. St. Louis, Mo.

January 10-17—American Road Builders' Association, annual convention and road show. Hotel Jefferson and St. Louis Arena. St. Louis, Mo.

January 19-22—National Crushed Stone Association, fourteenth annual convention. New Hotel Jefferson, St. Louis, Mo.

January 21-23—National Cinder Concrete Products Assn., annual convention. Atlantic City, N. J.

January 26—National Ready-Mixed Concrete Association, annual convention. Hotel Jefferson, St. Louis, Mo.

January 27-29—National Sand and Gravel Association, fifteenth annual convention and exhibit of machinery and equipment. Hotel Jefferson, St. Louis, Mo.

February 23-26—Concrete Masonry Association and Wisconsin Concrete Products Association, joint annual convention. Hotel Schroeder, Milwaukee, Wis.

February 24-26—American Concrete Institute, annual convention. Hotel Schroeder, Milwaukee, Wis.

Glacial Sand-Gravel Aggregate Found Suitable for Paving Work

Kansas Engineers Test Effect of Varying Mixes, Water-Cement Ratios and Amount of Fine Material on Compressive and Flexural Strength and Wear Resistance

By **L. H. KOENITZER**
Kansas State Agricultural College, Manhattan, Kans.

IN the past few years there has been an increase in demand for concrete materials, especially in states having large paving programs. Quite often the construction of a paved road depends upon the availability of local materials. In the eastern part of Nebraska and over portions of Kansas there is available glacial material which has a maximum size of 1½ inches. Most of the material passes a ¾-inch mesh sieve and has a fineness modulus of 4.10 to 4.50. This material is locally known and specified as total-aggregate material. Because of the small amount of available information on total aggregate it was decided to make extensive tests on the concrete-making qualities of this aggregate to determine the range of its possibilities.

In co-operation with the Engineering Experiment Station of Kansas State Agricultural College and the Kansas State Highway Commission, a study was made on over 450 nine-inch spheres for wear tests, 140 6 by 6 by 35-inch beams for flexure tests, and 500 3 by 6-inch cylinders for compression tests.

This paper will discuss the effect of the following variables upon the compression strength of concrete, the flexure strength of concrete, and the wearing qualities of concrete:

1. The effect of fines (material passing the 28-mesh sieve).
2. The effect of the fineness modulus.
3. The effect of variable mixes.
4. The effect of variable water-cement ratios.

Outline of Tests

Workability—Two experienced cement operators were used in making the slump and flow tests. The standard A.S.T.M. (D 138-26T) method was observed in the making of the slump tests. The flow was determined on a 28-inch aluminum table. A truncated cone 6¾ inches in diameter at the top and 10 inches in diameter at the bottom and 5 inches high was used. The flow was determined by raising the table one-half inch and dropping it, at the rate of 15 times in 15 seconds. Previous work has shown that there is a direct relationship between slump and flow. However, the slump test is better adapted to field use and perhaps is more easily understood by the average layman.

Wear Tests—Considerable work has been done by C. H. Scholer[1] and Harold Allen[1] in the development of a test that would determine the abrasive resistance of concrete. It was found that specimens made in a cast iron mold consisting of two hollow hemispheres with a half of a tapered neck or opening on each, and with lugs on the sides for fastening the two hemispheres together, gave very satisfactory results. The two surfaces where the castings came together were carefully machined. The two parts of the molds were fastened together with ¼-inch bolts which made the molds practically watertight. The concrete spheres were stored in the moist room the first 28 days, after which time they were stored at room temperature until 60 days old (See Figure 1). At this age three balls of the same mix were weighed and placed in the standard brick rattler. The rattler was standardized and run as if a standard test were being made on paving brick. At the end of the 1800 revolutions the three concrete balls were removed from the rattler and weighed. The loss in weight was indicative of the amount of wear the concrete would withstand and would be comparable with other mixes. Knowing the loss due to wear the depth of wear can be taken directly from a graph,[2] shown in Figure 2.

Flexure Tests—The beam specimens were tested in a field testing machine designed for paving tests. The load was applied at the center of the beam over a span of 18 inches. The machine is very sensitive and gives very good results.

Compression Tests—Compression tests were made on 3 by 6-inch concrete cylinders. The specimens were tested in a Tinius Olsen 50,000-pound testing machine with a 3-inch spherical bearing on top. The load was applied at the rate of 0.05 of an inch per minute.

Materials

Cement—The cement was a standard portland cement obtained from the local dealer from a fresh car of cement. Sufficient cement was bought at one time to furnish the entire project.

Sand-Gravel—The sand-gravel aggregate was bought from a glacial deposit at Blue Rapids, Kansas. The material was screened into four different sizes and recombined to give the necessary fineness modulus and the correct per cent of fines (material passing the 28-mesh sieve).

Mixing Water—The water used was obtained from the Kansas State College supply, which is used for drinking purposes. The mixing water was kept at 70 degrees F. throughout the experiment.

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[1] *Wear Tests of Concrete*, by C. H. Scholer and Harold Allen, Engineering Experiment Station Bulletin, No. 20, K. S. A. C.

[2] From *Wear Tests of Concrete*, by C. H. Scholer and H. Allen, Engineering Station Bulletin, No. 20, K. S. A. C., page 8.

Figure 1. Cylinders and wear-test specimens stored in laboratory after being cured in moist room

Weighing—All materials were weighed on scales, which were sensitive to 0.05 of a pound.

Mixing—All materials were put in a mixer and mixed for 2 minutes. The mixer made 18 revolutions per minute. Enough material was mixed at one time for three 9-inch spheres, one 6 by 6 by 35-inch beam specimen, and six 3 by 6-inch cylinder specimens.

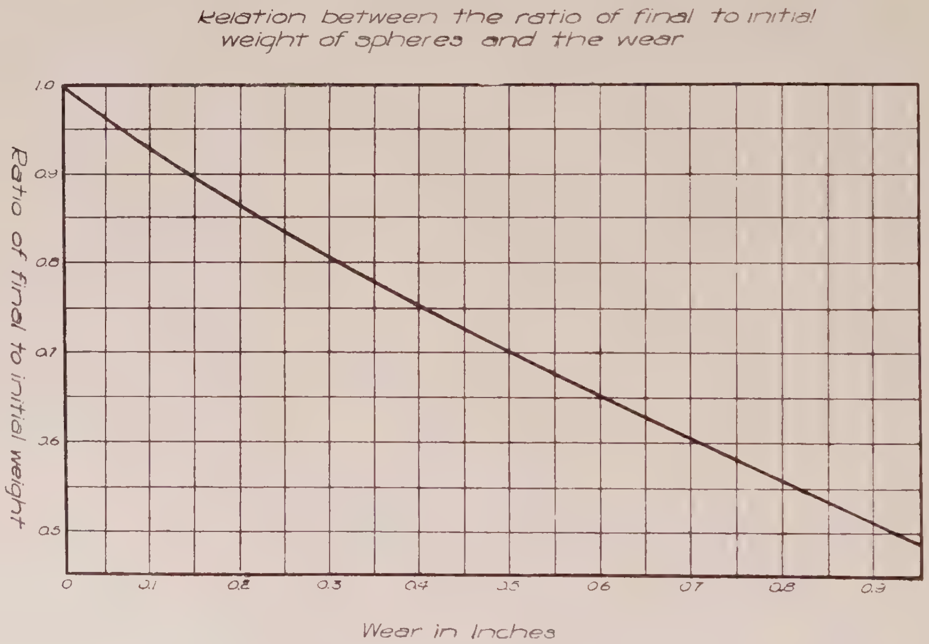

Figure 2. Graph showing relation between percentage and depth of wear

Molding of Specimens

The molds for the 3 by 6-inch cylinders were made of seamless tubing split down the side. The molds were all machined to a constant volume. The molds were fastened to 4 by 4-inch glass plates with paraffin, thus making them practically watertight. The concrete was placed in the molds in 2-inch layers, each layer being tamped 25 times with a ⅞-inch tamping rod. The beam specimens were made in 2-inch wooden forms with an inside dimension of 6 by 6 by 35 inches. The concrete was placed in the molds in 3-inch layers, each layer being tamped 150 times with a ⅝-inch bullet-pointed rod. Two cutting strokes were made on each side of the specimen with a brick trowel. The 9-inch concrete spheres were made by filling the mold one-third full, tamping each layer 25 times with a ⅝-inch bullet-pointed rod 22 inches long.

Curing

The specimens were covered with wet burlap the first 24 hours, after which time they were removed from the molds and were stored in the moist room for 28 days. At the end of 28 days three of the 3 by 6-inch cylinders from each batch were tested in compression. The other three specimens from each batch were placed with the

TABULATION OF TEST RESULTS

Specimen Number	Mix	W/C	G.F.	Per Cent Fines	Compression Strength, 28-day	Modulus of Rupture, 28-day	Per Cent of Wear, 60 days	Cement Factor, Barrels
3AX	1:3.00	.7	3.50	15	3923	632	10.64	1.95
3BX	1:3.25				4028	642	11.20	1.82
3CX	1:3.50				2498	520	13.97	1.72
3DX	1:3.75				3459	578	13.42	
3EX	1:4.00				3247	541	14.55	
4AX	1:3.00	.7	3.80	15	3638	685	11.45	2.04
4BX	1:3.25				3475	580	11.77	1.91
4CX	1:3.50				2963	560	13.87	1.80
4DX	1:3.75				2911	495	13.97	1.70
4EX	1:4.00				1554	489	26.15	1.61
1AX	1:3.00	.7	4.10	15	3952	684	10.32	1.97
1BX	1:3.25				4058	670	11.36	1.82
1CX	1:3.50				3667	642	10.53	1.72
1DX	1:3.75				3899	681	12.53	1.62
1EX	1:4.00				3563	631	12.40	1.53
2AX	1:3.00	.7	4.50	15	3893	730	10.81	1.95
2BX	1:3.25				3862	736	9.18	1.78
2CX	1:3.50				4866	767	8.33	1.78
2DX	1:3.75				3681	701	10.86	1.58
2EX	1:4.00				3384	645	11.96	1.48
3N10	Variable	.6	3.50	10	5078	656	9.39	2.11
3N20	with	.7			4465	624	11.41	1.83
3N30	W/C	.8			3764	600	15.21	1.64
3N40		.9			3052	583	20.68	1.54
3N15	Variable	.6	3.50	15	4462	647	15.39	2.08
3N25	with	.7			3300	600	19.69	1.72
3N35	W/C	.8			3431	508	23.93	1.70
3N45		.9			2343	369	34.68	1.40
4N10	Variable	.6	4.10	10	4857	816	7.51	2.55
4N20	with	.7			4310	626	12.23	2.09
4N30	W/C	.8			2675	561	15.39	1.86
4N40		.9			3113	529	16.39	
4N15	Variable	.6	4.10	15		781	8.19	2.36
4N25	with	.7			3120	645	14.68	2.04
4N35	W/C	.8			3436	527	16.94	1.80
4N45		.9			2789	486	19.73	1.85
5N33	1:3.25	.7	3.30	15	4239	508	14.99	1.94
5N34			3.40		3603	531	15.50	1.94
5N35			3.50		3735	596	12.47	1.89
5N36			3.60		3736	626	13.49	1.89
5N37			3.70		3666	612	12.57	1.89
5N38			3.80		3958	616	11.76	
6N38	1:3.50	.7	3.80	15	4064	653	12.68	1.78
6N39			3.90		3756	598	12.35	1.76
6N40			4.00		4107	649	11.58	1.76
6N41			4.10		4431	618	12.93	1.74
7N41	1:3.75	.7	4.10	15	4298	639	14.85	1.62
7N42			4.20		4282	666	10.43	1.62
7N43			4.30		4827	638	15.00	1.62
7N44			4.40		4284	656	13.47	1.60
8N44	1:4.00	.7	4.40	15		608	12.19	1.52
8N45			4.50			601	11.07	1.53
8N46			4.60			595	12.70	1.52
8N47			4.70			599	10.35	1.48
H10	1:3.25	.7	3.50	10	2637	471	19.78	1.88
H15				15	2413	503	20.18	1.86
H20				20	3268	474	18.73	1.83
I10	1:3.50	.7	3.80	10	2583	532	18.52	1.77
I15				15	2694	540	17.81	1.78
I20				20	2726	565	17.63	1.74
J10	1:3.75	.7	4.10	10	2711	547	19.05	1.70
J15				15	None	None	17.20	1.71
J20				20	2700	587	15.65	1.68
K10	1:4	.7	4.50	10	3129	536	19.04	1.64
K15				15	2564	548	16.15	1.62
K20				20	2861	548	15.81	1.61

9-inch spheres in the laboratory, where the temperature remained at 70 degrees F. (See Figure 1). Each beam specimen was tested at two ages, 7 and 28 days. At the age of 60 days the cylinder and sphere specimens were tested.

Summary and Conclusions

The data in the tables that follow are a summary of a number of tests. Each value of the wear tests is the average of six specimens; the flexure tests, the average of two specimens; and the compression tests, the average of four specimens each. The following results are indicated by these tests:

For a mix of 1:3.25 by volume, the modulus of rupture increased as the fineness modulus of the mix increased from 3.30 to 3.80 (15 per cent passing the 28-mesh sieve). The wear for the same mix decreased as the fineness modulus increased. The compressive strength of the concrete remained practically constant.

For a mix 1:3.50 by volume, the fineness modulus varying from 3.80 to 4.10, the modulus of rupture, compressive strength and per cent of wear were practically constant for the varying fineness moduli.

For a mix of 1:3.75 by volume and a fineness modulus varying from 4.10 to 4.40 and for a mix 1:4.00 by volume, fineness modulus varying from 4.40 to 4.70, the modulus of rupture, per cent of wear and compressive strength were practically the same for each mix with varying gradation factors.

The modulus of rupture and compressive strength increased with the mix as the cement factor decreased for mixes up to and including 1:3.75 by volume.

The Effect of Fines

The data indicate that for variable mixes, with constant water-cement ratios and fineness moduli of 3.50 and 4.50, the mixes containing 20 per cent passing the 28-mesh sieve gave higher strength values than similar mixes containing 10 and 15 per cent passing the 28-mesh sieve.

The Effect of Variable W/C Ratios

For all mixes and fineness moduli studied, an increase in the water-cement ratio decreased the strength and increased the per cent of wear of the concrete.

Fineness Modulus

The following mixes gave the greatest strength both in flexure and compression for the following fineness moduli:

Fineness Modulus	Mix (by volume)
3.50	1:3.25
3.80	1:3.00
4.10	1:3.75
4.50	1:3.50

The results of using total aggregate on six miles of paving showed an average modulus of rupture greater than 560 lb. per sq. in. at 10 days, and a compressive strength of 3800 lb. per sq. in. at 28 days. Total aggregate seems to give satisfactory results in paving construction work when proper precautions are taken for the expanding and contracting of the concrete. It is common practice to reinforce total aggregate concrete with fifty-pound mesh.

Bridge With Mammoth Concrete Spans Opened to Traffic at Brest

Three Hollow-Ribbed Arches of 610 Feet Each Are Longest Concrete Spans in Existence

The 3-span reinforced concrete arch bridge built across the estuary of the River Elorn, at Brest, France, connecting Brest and Plougastel, was formally opened to traffic on October 9, states a special news dispatch to the *Christian Science Monitor.* A noteworthy fact about this bridge is that the span length of the arches (610 feet) is considerably in excess of any other reinforced concrete arches in existence.

With the formal opening of the great reinforced concrete bridge at Plougastel, four miles east of Brest, says the *Monitor* news article, one of the major engineering feats of modern France is brought to completion.

The method of construction employed attracted public attention for many months. A single arch of wood was used as a mold for each of the three spans. As soon as one arch was finished, the mold was floated on specially built pontoons to its position for the second arch, and later to the position of the third arch. Work was commenced on the bridge early in 1928.

The Plougastel bridge spans the Elorn, and brings Brest into closer touch with the south of Finisterre.

The bridge is 880 meters, more than half a mile, in length. Each of its three arches is 186 meters, about 610 feet, long. It has two levels, the upper reserved for road traffic and a suburban railway, the lower for railroad tracks exclusively. It was built by the Société des Entreprises Limousin.

Early stages of construction of this history-making structure were described and illustrated in CONCRETE in March, 1929, and October, 1926.

Cast Stone Freight Rate Case Postponed

The hearing before the Interstate Commerce Commission on the subject of freight rates on cast stone, originally scheduled for September 3, 1930, and then postponed to December 2, has been postponed indefinitely.

Previously the Commission had ordered suspension of the higher freight rates on cast stone until February 1, 1931, as stated in the August, 1930, issue of CONCRETE, page 42. In the meantime the special freight rate committee appointed by the Cast Stone Institute and a similar committee appointed by the natural stone interests are holding a series of meetings with a committee representing the carriers, in an endeavor to come to an agreement on matters such as descriptions, rates and minimum carloads for cast stone and natural stone shipments.

In the event that an agreement is reached with the carriers, a combined report and recommendations will be made back to the Interstate Commerce Commission.

Paving Mixer Serves as Portable Mixing Plant

A paving mixer with a long chute attached was employed during the month of October as a portable mixing and distributing plant in the construction of long concrete walls at the Dempster Road-Milwaukee Road grade separation work in Cook County, Illinois.

The two roads have both been paved with concrete for some years, crossing each other at grade. The grade separation work involves depressing the central part of Dempster Road, and this plan required the construction of long concrete walls below grade, along the depressed part of the road.

Paving mixer doing duty as portable concrete mixing plant

Accordingly, the first excavation included only what was necessary for construction of the walls. Meanwhile the excavation and pavement in the central part of the road was left in place. The Koehring mixer operates back and forth on this pavement.

The illustration shows the manner in which the chute is suspended from the boom regularly employed on paving work. The movement of the chute is, of course, controlled by the boom.

The aggregates are delivered by trucks to the skip of the paver, as in paving construction.

Stevens Master Specifications in New Edition

The third annual edition of the Stevens Master Specifications has been issued by Stevens Master Specifications, Inc., 165 W. Wacker Drive, Chicago.

In the part of the publication dealing with concrete the new edition contains a revised and complete master specification covering the design, mixing and placing of concrete in accordance with the water-cement ratio control method.

These specifications are issued in loose-leaf form, 8½ by 11 inches in size. As the title implies, the publication is designed for the use of architects and specification writers, and it covers all materials that enter into the make-up of a building, from the structural materials to the finishing products and processes.

"Five Scattered Hospital Buildings Concreted from One Plant"

The article of the above title, published beginning on page 17 of the December issue of CONCRETE, stated that "The mixing is continued for about 1 minute and 10 seconds."

Corrected, this statement should have read, "While the concrete could have been mixed in 1 minute 10 seconds, it was kept in the mixer 1½ minutes because the superintendent wished to follow exactly the specification requirements on this project."

Concrete Benches Reduce Maintenance Costs in Greenhouses

Eastern Wholesale Florists Replace Wooden Soil Benches With Concrete—Precast Slabs Used in One Case—Moist Air Ideal for Curing Concrete

GREENHOUSES offer a good market for concrete construction and one which concrete contractors can profitably develop. From the East, for example, comes the following interesting story of how two large wholesale florists have utilized concrete in their greenhouses to decrease their maintenance expenses.[1]

A. N. Pierson, Inc., of Cromwell, Connecticut, one of the largest greenhouse groups in the United States, supply roses, gardenias, orchids and other decorative plants to the New York market. To handle these flowers, this company maintains 96 greenhouses with a total ground area of nearly 1,200,000 square feet, or more than 25 acres.

High Replacement Costs Force Use of Concrete

Necessary repairs and replacements of the soil benches in these 96 greenhouses made the annual operating costs unusually high. The company officials, therefore, decided gradually to reconstruct all soil benches with concrete. To date, 256 benches with a total length of 98,193 feet, have been built.

This wholesale florist built 98,000 linear feet of monolithic concrete soil benches

Accompanying photographs show the type of concrete soil benches that are being built. They vary from 200 to 400 feet in length. A bench consists of two curbs, each of which is 16 inches high, 2 inches wide at the top and 4 inches wide at the bottom. The aisle side of the curb is vertical and the inside is battered. The two curbs for the entire length of a bench are cast in one operation by means of special steel forms which are used over and over again. No joints of any kind are provided in the curbs and no attention is given to cracks caused by expansion and contraction because they in no way affect the service of the curbs. These benches have proved to be very successful and have aided materially in reducing maintenance costs.

Approximately 1,300 cubic yards of concrete are used annually by A. N. Pierson, Inc., in the construction of these new benches and for walks, driveways and other improvements around its plants.

Trendley and Schenk, of Rowayton, Connecticut, another large wholesale floral concern supplying the New York market, also use concrete for greenhouse soil benches. As in the case of A. N. Pierson, Inc., this firm found that repair and replacement expenses in their greenhouse benches were too high and decided to replace them with permanent benches of concrete.

Casting thin reinforced concrete slabs for soil benches

Use Precast Concrete Slabs

The benches built by Trendley and Schenk consist of precast 1-inch reinforced slabs, 12 inches high. Eight-foot lengths are used for sides and 2-foot 6-inch lengths

Two of 75 precast concrete soil benches built for this company for ends. They are held in position by means of cast iron angles driven into the ground at the corners. The precast slabs are made in steel forms using a 1:2 mortar and reinforced with ½-inch galvanized mesh. Sixty slabs are required for each soil bench. At present there are 75 benches in use, requiring 4,500 slabs.

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[1] See also article by Walter B. Balch in the May, 1930, issue of CONCRETE, pages 49-50.

Weight Most Important Factor in Slag Aggregate

Compressive and Flexural Strengths of Slag Concrete Increase and Absorption Decreases With Increased Weight of Slag

RELATION Between the Abrasion Loss of Blast-Furnace Slag and Its Concrete-Making Properties is the title of a 34-page 6 by 9-inch pamphlet published by the National Slag Association, 937 Leader Building, Cleveland, Ohio.

The pamphlet is a reprint of a report of section of Committee C-9, on Concrete and Concrete Aggregates of the American Society for Testing Materials. The data presented in the report are divided into two parts, the first of which deals with data developed prior to the time when the subject was assigned to the committee, while the second covers data developed during the committee's studies. This second part of the report covers the results of tests on twenty commercial slags conducted by five laboratories that co-operated with the committee.

The loose weight of the slags tested ranged from 56.7 to 89.7 lb. per cu. ft. The compacted weight ranged from 63.4 to 99.6 lb. per cu. ft.

Compressive Strength Increases With Weight of Slag

The conclusions resulting from the tests performed by the five laboratories, so far as compressive strength of the concrete is concerned, are to the effect that both the weight per cubic foot limitation and abrasion tests will eliminate undesirable materials when measured by the compressive strength of the resulting concrete. The abrasion tests, however, will also eliminate a considerable number of entirely satisfactory materials, while a minimum weight requirement of 70 lb. per cu. ft. would eliminate only one slag which made concrete of satisfactory compressive strength. The conclusion is therefore reached that weight per cubic foot of the slag is the best indicator of the compressive strength that may be expected from slag concrete.

Flexural Strength

Conclusions as to flexural strength were similar to those regarding compressive strength, namely, that the abrasion test on slag is not a reliable indicator of the relative flexural strength of slag concrete. The weight of the slag per cubic foot, on the other hand, is a reliable indicator of flexural strength. As with compressive strength, the flexural strength of the concrete increases with the weight of the slag.

Wear of Slag Concrete

No definite relation could be established between the amount of abrasion of the slag and the amount of wear of the concrete. Very generally speaking, the concrete containing heavy slags (more than 80 lb. per cu. ft.) gave the least wear, although the erratic results obtained would indicate that the methods used for making the wear tests were not dependable.

Absorption Highest With Lighter Weight Slags

The absorption of the concrete was found, in general, to have little or no relation to the abrasion losses of the slag. The weight of the slag per cubic foot, however, is a very good indicator of the relative absorption that may be expected in the concrete. Generally, the lighter weight slags produced concrete having higher absorption.

Unit Weight the Best Indicator

There seems to be little question that the quality of slag concrete is more definitely indicated by the unit weight of the slag than by its abrasion losses.

National Cinder Concrete Products Meeting in Atlantic City

The National Cinder Concrete Products Association will hold its 1931 convention in Atlantic City, N. J., on January 21, 22 and 23. A survey of the manufacturing efficiency of the industry, based on a study of sixteen plants, will comprise an important part of the program.

Sales, credits and collections, publicity and the certified units plan are other subjects scheduled.

Personals

Frederick O. Anderegg, Ph.D., announces the opening of a consulting practice on building materials, including portland cement, cement products and masonry, at the Fulton Building, Pittsburgh, Pa.

He was formerly associate professor of physical chemistry at Purdue University and more recently senior industrial fellow at the Mellon Institute of Industrial Research, in charge of investigations of portland cement and masonry.

E. W. Dienhart, formerly vice-president of the H. H. Potts Company, Chicago, has been appointed sales manager of the Macotta division of the Maul Company, with offices and plants at Chicago and Detroit. This company manufactures metal-faced concrete slabs and blocks for exterior and interior ornamental work in building construction.

Eric E. Traversy, formerly engaged in special work for the Portland Cement Association in Chicago and New York, has opened an office in the New Birks Building, 620 Cathcart St., Montreal, Quebec, for the promotion and advertising of engineering and building materials.

Joah Etchells announces that the business of Richard K. Meade & Co., at Baltimore, Maryland, will be continued by him as president and general manager under the name of Richard K. Meade & Co., Inc., chemical and industrial engineers.

J. Singleton-Green has recently joined the staff of G. & T. Earle, Limited, at Hull, England. He heads the British cement company's technical department.

How to Save in Concrete Form Work

Type of Labor—Scope and Nature of Cost Estimates—Re-Use of Form Lumber

XII—Estimating the Cost of Form Work

PART II

By A. B. MacMILLAN
Chief Engineer, Aberthaw Company, Boston, Mass.

This is the second half of the final installment of Mr. MacMillan's series of articles. He continues with the estimation of various form work parts for definite areas.

The first installment of the series appeared in the January, 1930, issue.—The Editors.

LABOR and material quantities will now be estimated for definite areas, such as 400 or 1,000 sq. ft., for various parts of the form work for a building, taken practically in the order in which the form work itself was discussed in previous chapters.

In each case the form area considered is the actual area of the surface of contact between the forms and the concrete.

Hours of labor required will be expressed as the equivalent number of hours for one man. For instance, if it is estimated that certain work will take four carpenters three hours, the work required will be expressed as 12 hours of carpenter labor.

It is probably true that no two contractors keep their unit form costs in the same way. We ordinarily charge a proportion of the carpenter foreman's time, labor foreman's time, plant charges, and such other items of supervision as apply directly to the work. We do not include plant charges such as saw-benches; but the cost of make-up benches, templates when needed, lumping to saw-benches and make-up benches, lumping panels from the make-up yard to the place of use, must all be included. Some of these items are performed by carpenters or carpenters' helpers, and some by common laborers.

Another point to remember in estimating form labor is that the form work for wall and column footings and for foundation walls will be hampered and delayed by excavating and sheeting, and because the form crew has not yet developed organization and team work. This part of the form work will not be done as expeditiously as above the first floor.

Wall Footings

(1) Let us assume a wall footing 12 in. deep and 3 ft. wide, of the type illustrated in Figure 1(a), and estimate the form labor and material required for 400 sq. ft. of form area. Under the conditions assumed this will mean a stretch of wall 200 ft. long.

Lumber for 400 Sq. Ft.:

25 pieces of 2-by-12's, 16 ft. long, for sides	800 bd. ft.
22 pieces of 2-by-4's, 16 ft. long, for stakes and separators	235 bd. ft.
Total lumber	1,035 bd. ft.
Form lumber per sq. ft. of form area	2.6 bd. ft.

Other Materials:

10d double-headed nails	2 lb.

Labor for 400 Sq. Ft.:

Placing sides, separators and stakes, carpenter labor	35 hrs.
Stripping, carpenter labor	3 hrs.
Cleaning forms, handling material and moving forward, common labor	7½ hrs.

(2) Assume a wall footing of the type illustrated in Figure 1(b), 24 in. deep and 3 ft. wide, and estimate the form labor and material required for 400 sq. ft. of form area. With the dimensions assumed, the stretch of wall being considered is 100 ft. long.

Lumber for 400 Sq. Ft.:

38 pieces 1-by-8's, 16 ft. long, for sides	406 bd. ft.
21 pieces 1-by-4's, 16 ft. long, for battens and braces	112 bd. ft.
2 pieces 1-by-2's, 16 ft. long, for stakes	11 bd. ft.
34 pieces 2-by-4's, 16 ft. long, for liners, separators and stakes	363 bd. ft.
4 pieces 2-by-8's, 16 ft. long, for props	86 bd. ft.
Total lumber	978 bd. ft.
Form lumber per sq. ft. of form area	2.45 bd. ft.

Other Materials:

10d double-headed nails	5 lb.
6d double-headed nails	3 lb.

Labor for 400 Sq. Ft.:

Making up battened sides, including repairs, carpenter labor	20 hrs.
Placing forms, carpenter labor	35 hrs.
Stripping, carpenter labor	3 hrs.
Cleaning, handling material and moving forms forward, common labor	7½ hrs.

Column Footings

(1) *Box or Stepped Footings.* Assume column footings of the box or stepped type shown in Figures 2 and 3, the lower slab being 5 ft. square and 16 in. deep, and the pedestal or upper step being 3 ft. square and 16 in. deep. The form area of one footing (the actual area of the sur-

face of contact between the forms and the concrete) is about 43 sq. ft.

Instead of estimating the form labor and material for a certain number of footings, as nine or ten, let us base the estimate on 400 sq. ft. of such form work, in order that the figures in the estimate may be applied more conveniently to other cases.

Lumber for 400 Sq. Ft.:

47 pieces 1-by-8's, 16 ft. long, for sides	502 bd. ft.
21 pieces 2-by-4's, 16 ft. long, for cleats, stops and separators	224 bd. ft.
Total lumber	726 bd. ft.
Form lumber per sq. ft. of form area	1.82 bd. ft.

Other Materials:

8d ordinary wire nails	6 lb.
10d double-headed nails	6 lb.
Twisting wire, No. 10	400 lin. ft.
Twisting bars, 3/8 in. rods, 12 in. long	40 req'd

Labor for 400 Sq. Ft.:

Making up sides, including repairs, carpenter labor	25 hrs.
Assembling forms, carpenter labor	38 hrs.
Stripping, carpenter labor	3 hrs.
Cleaning forms, handling material and carrying forms forward, common labor	7½ hrs.

(2) *Sloped Footings.* Assume column footings of the sloped type illustrated in Figures 5 and 6. Assume the dimensions of the footing and the form panels as given in Figures 5 and 6; that is, the base of the footing is 6 ft. 8 in. square, the top is 2 ft. square, the straight side at the base is 10 in. high and the sloped part is 2 ft. 6 in. high. The form area of one footing is about 83 sq. ft., but again we will base our estimate on an even 400 sq. ft. of form surface, in order that the figures may be applied conveniently to other cases.

Lumber for 400 Sq. Ft.:

56 pieces 1-by-6's, 16 ft. long, for sloped sides of footings	448 bd. ft.
10 pieces 1-by-10's, 16 ft. long, for sides of base	134 bd. ft.
25 pieces 2-by-4's, 16 ft. long, for battens and stakes	267 bd. ft.
Total lumber	849 bd. ft.
Form lumber per sq. ft. of form area	2.12 bd. ft.

Other Materials:

10d ordinary wire nails	20 lb.
5-in. lag screws	40 req'd

Labor for 400 Sq. Ft.:

Making up sides, including repairs, carpenter labor	25 hrs.
Assembling and stripping forms, carpenter labor	38 hrs.
Cleaning forms, handling material and carrying forms forward, common labor	7½ hrs.

Foundation Walls

The wall here considered is an ordinary foundation wall of a building, for which the footing has previously been built. The type of form work is shown in Figure 7, ties and separators being employed so as to eliminate exterior bracing.

For the purpose of this estimate, assume a wall 16 in. thick and 7 ft. 6 in. high, and estimate the form labor and material required for 1,000 sq. ft. of form area. This will comprise a stretch of wall 66 ft. 8 in. long.

With the height of wall assumed, three tiers of wall form units of the type detailed in Figure 7 will be required. The estimate will be made on the assumption that wire loops and wooden separators will be used, rather than the tie bolts and concrete separators illustrated in Figure 7 as an alternate method which should be employed in high foundation walls.

Lumber for 1,000 Sq. Ft.:

102 pieces 1-by-8's, 16 ft. long, for panels	1,088 bd. ft.
4 pieces 1-by-6's, 16 ft. long, for cleats	32 bd. ft.
35 pieces 1-by-4's, 16 ft. long, for splices	187 bd. ft.
10 pieces 1-by-2's, 16 ft. long, for spreaders	27 bd. ft.
29 pieces 2-by-4's, 16 ft. long, for cleats	310 bd. ft.
4 pieces 1-by-2's, 16 ft. long, hardwood for blocks 6 in. long	11 bd. ft.
4 pieces 1-by-2's, 16 ft. long, hardwood for wedges, dressed to wedge shape 6 in. long	11 bd. ft
Total lumber	1,666 bd. ft.
Form lumber per sq. ft. of form area	1.67 bd. ft.

Other Materials:

Wire, No. 10	600 lin. ft.
8d ordinary wire nails	25 lb.
10d double-headed nails	40 lb.

Labor for 1,000 Sq. Ft.:

Making up panels, including repairs, carpenter labor	48 hrs.
Erecting panels, carpenter labor	96 hrs.
Stripping, carpenter labor	12 hrs.
Cleaning forms, handling material and carrying forms forward, common labor	12½ hrs.

Interior Columns

It will be necessary, to make the estimates complete, to compute the labor and material required for each of the four types of columns for which form work is detailed in Figures 10, 11, 12 and 13. In each case the story height will be assumed at 12 ft., measuring from floor level to floor level. Figure 9 shows that eight column yokes will be required at each column. The height of the column forms will, in general, be 12 ft. less the thickness of the floor slab; but the lumber required will, of course, be in 12-ft. lengths.

(1) *Square Interior Columns of Moderate Size.* This type is shown in Figure 10. Assume a column 16 in. square, story height 12 ft., and a floor slab 5 in. thick, and estimate the labor and material required for 1,000 sq. ft. of actual form area. Each column of the size assumed will have 61.8 sq. ft. of form area, without taking account of notches for girders, so that 1,000 sq. ft. will be the equivalent of about 16 columns.

Lumber for 1,000 Sq. Ft.:

130 pieces 1-by-8's, 12 ft. long, planed to required widths	1,040 bd. ft.
65 pieces 1-by-2's, 12 ft. long, for strips in column sides	130 bd. ft.
130 pieces 2-by-4's, 16 ft. long, for clips, cleats and blocks in yokes	1,387 bd. ft.
16 pieces 1-by-2's, 16 ft. long, hardwood for wedges, dressed to wedge shape 6 in. long	43 bd. ft.
Total lumber	2,600 bd. ft.
Form lumber per sq. ft. of form area	2.60 bd. ft.

Other Materials:

7/8-in. corner fillets	800 lin. ft.
16d spikes	75 lb.
10d ordinary wire nails	30 lb.
6d ordinary wire nails	5 lb.

Labor for 1,000 Sq. Ft.:

Making up column sides, including repairs, carpenter labor	48 hrs.
Erecting forms, carpenter labor	96 hrs.
Stripping, carpenter labor	12 hrs.
Cleaning forms, handling material and carrying forms forward or hoisting to floor above, common labor	12½ hrs.

(2) *Square Interior Columns of Large Size.* Form work for this type of column is illustrated in Figure 11. Assume a column 30 in. square, a story height of 12 ft. from floor level to floor level, and a floor slab 5 in. thick, and estimate the labor and material for 1,000 sq. ft. of form area. Each column of the size assumed will have 115.8 sq. ft. of form area, without taking account of notches for girders. Consequently 1,000 sq. ft. will be the equivalent of between eight and nine columns.

Lumber for 1,000 Sq. Ft.:

18 pieces 1½-by-10 lagging, 12 ft. long, dressed 4 sides and planed to required widths	360 bd. ft.
104 pieces 1½-by-8 lagging, 12 ft. long, dressed 4 sides and planed to required widths	1,664 bd. ft.
35 pieces 1½-by-4 lagging, 12 ft. long, dressed 4 sides and planed to required widths (for strips)	280 bd. ft.
35 pieces 1-by-2's, 12 ft. long, for strips	70 bd. ft.
90 pieces 3-by-4's, 16 ft. long, for cleats and clips	1,440 bd. ft.
Total lumber	3,814 bd. ft.
Form lumber per sq. ft. of form area	3.82 bd. ft.

Other Materials:

⅞-in. corner fillets	450 lin. ft.
8d ordinary wire nails	36 lb.
10d double-headed nails	8 lb.
6d ordinary wire nails	3 lb.
⅝-in. bolts, 42 in. long, with sq. hd. and nut and 2 washers to each	138 req'd

Labor for 1,000 Sq. Ft.:

Making up column sides, including repairs, carpenter labor	64 hrs.
Erecting forms, carpenter labor	96 hrs.
Stripping, carpenter labor	12 hrs.
Cleaning forms, handling material and carrying forms forward or hoisting to floor above, common labor	12½ hrs.

(3) *Octagonal Columns.* For details of this type of column forms, see Figure 12. Assume a 30-in. column, as shown in Figure 12. As before, assume a story height of 12 ft. from floor level to floor level and a floor slab 5 in. thick. The form area of one column, including notches for girders, is 91 sq. ft., so that 1,000 sq. ft. of area will be equivalent to eleven columns. There will be eight strap iron yokes to each column.

Lumber for 1,000 Sq. Ft.:

88 pieces 2-by-12 lagging, 12 ft. long, dressed 4 sides and planed to required width	2,112 bd. ft.
Form lumber per sq. ft. of form area	2.11 bd. ft.

Other Materials:

176 pieces strap iron, ⅜ by 2½ in., 58 in. long, holes drilled as shown in detail	2,850 lb.
⅝ by 3-in. machine bolts, sq. hd. and nut, and 4 washers with each bolt	176 req'd
Wood screws, 1½ in. long, No. 10 gauge, round heads	2,000 req'd

Labor for 1,000 Sq. Ft.:

Making up half-round column sides, including repairs, carpenter labor	64 hrs.
Erecting forms, carpenter labor	96 hrs.
Stripping, carpenter labor	12 hrs.
Cleaning forms, handling material and carrying forms forward or hoisting to floor above, common labor	12½ hrs.

(4) *Circular Column.* Although forms for this type of column are almost invariably made of metal, an estimate will nevertheless be made on the basis of the details in Figure 13. Again assume a 30-in. column, a story height of 12 ft., and a floor slab 5 in. thick. The form area of one column is 91 sq. ft., including notches for girders, so that 1,000 sq. ft. of form area is again equivalent to eleven columns. Each column will have three of the wooden yokes illustrated in Figure 13, and eight of the steel hoops fitted with tank lugs to permit tightening.

Lumber for 1,000 Sq. Ft.:

374 pieces 1½-by-3 lagging, 12 ft. long, dressed 4 sides and planed to required width	2,244 bd. ft.
75 pieces 1-by-12's, 14 ft. long, dressed and cut to detail for column yokes	1,050 bd. ft.
Total lumber	3,294 bd. ft.
Form lumber per sq. ft. of form area	3.30 bd. ft.

Other Materials:

Steel hoops, ⅜-in. round by 110 in. long, each fitted with a tank lug, as detailed	88 req'd
⅝-in. bolts, 20 in. long, with sq. hd. and nut, 2 washers to each bolt	100 req'd
8d ordinary wire nails	50 lb.

Labor for 1,000 Sq. Ft.:

Making up column sides (in 3 segments), including repairs, carpenter labor	64 hrs.
Erecting forms, carpenter labor	96 hrs.
Stripping, carpenter labor	12 hrs.
Cleaning forms, handling material and carrying forms forward or hoisting to floor above, common labor	12½ hrs.

Wall and Corner Columns

The form work for wall and corner columns, such as will be found detailed in Figures 15, 16 and 17, is similar to that for square interior columns of large size, and the quantities of material and hours of labor are very nearly the same. Consequently the quantities determined in the estimates previously given for the form work for those columns (Figure 11) may be applied to the area of form work for wall and corner columns.

Beam and Girder Sides

It is best to make a separate item covering beam and girder sides, because of the great variation in the area of this part of the form work compared with floor area.

However, we shall include here only the material that comprises the actual assembly of beam and girder sides. For instance, only the side form boards, the cleats, the liners, the fillets, the spreaders and the wire ties shown in Figure 20 will be included. All other form work shown in Figure 20 (except beam bottoms) will be included in the estimates for floor forms and their supports.

For the purpose of the estimate we shall assume girders to be 12 in. wide and 20 in. deep below the bottom of the slab, and beams 10 in. wide and 14 in. deep below the slab, and floor bays 20 ft. square. Details of form work are in accordance with Figures 19, 20, 21 and 22.

It should be remembered, too, that the girders extend in one direction, on each line of columns, and that the beams frame into the girders at the third-points of the span, and into the columns. This places the girders 20 ft. center to center in the case assumed, and the beams 6 ft. 8 in. center to center.

Lumber for 1,000 Sq. Ft.:

135 pieces 1 1/16-by-6's, 20 ft. long, for beam and girder sides	1,688 bd. ft.
34 pieces 2-by-4's, 16 ft. long, for cleats	363 bd. ft.
11 pieces 3-by-4's, 20 ft. long, for liners	220 bd. ft.
12 pieces 1-by-2's, 16 ft. long, for spreaders	32 bd. ft.
Total lumber	2,303 bd. ft.
Form lumber per sq. ft. of form area	2.30 bd. ft.

Other Materials:

⅞-in. corner fillets	1,700 lin. ft.
10d ordinary wire nails	50 lb.
10d double-headed nails	12 lb.
6d ordinary wire nails	9 lb.
Twisting wire, No. 10	200 lin. ft.
Twisting bars, ⅜-in. rods, 12 in. long	50 req'd

Labor for 1,000 Sq. Ft.:

Making up beam and girder sides, including repairs, carpenter labor	64 hrs.
Erecting forms, carpenter labor	80 hrs.
Stripping, carpenter labor	12 hrs.
Cleaning forms, handling material and carrying forms forward or hoisting to floor above, common labor	12½ hrs.

Beam and Girder Bottoms

The material and labor for placing beam and girder bottoms, like the beam and girder sides, will be estimated separately because of the variation in the area of this form work compared with the total floor area.

The dimensions of beams and girders and of floor bays will be the same as previously assumed under "Beam and Girder Sides," and labor and materials for 1,000 sq. ft. of form area will be figured. Only the actual beam and girder bottom planks and the wedges beneath them will be considered in this item.

Lumber for 1,000 Sq. Ft.:

16 pieces 2-by-12's, 20 ft. long, dressed, for girder bottoms	640 bd. ft.
46 pieces 2-by-10's, 20 ft. long, dressed, for beam bottoms	1,533 bd. ft.
33 pieces 2-by-3's, 16 ft. long, hardwood for wedges, dressed to wedge shape 6 in. long	264 bd. ft.
Total lumber	2,437 bd. ft.
Form lumber per sq. ft. of form area	2.44 bd. ft.

Labor for 1,000 Sq. Ft.:

Cutting to lengths, carpenter labor	30 hrs.
Erecting form work, carpenter labor	80 hrs.
Stripping, carpenter labor	12 hrs.
Cleaning forms, handling material and hoisting and distributing forms to floor above, common labor	12½ hrs.

Beam and Girder Floor Forms

The estimates under this heading will include all the form work and supporting timbers for floors of girder, beam and slab construction, except the beam and girder sides and bottoms included in the two items preceding this heading.

The dimensions of the floor bay and the size and framing of beams and girders will again be taken at the figures previously assumed. That is, the assumed floor bay will be 20 ft. square, girders will be 20 ft. center to center and beams 6 ft. 8 in. center to center. The story height will be assumed at 12 ft. from floor level to floor level.

Form labor and material will be figured for 1,000 sq. ft. of floor area, the gross horizontal area being considered. That is, the area assumed will be the equivalent of 2½ bays of 400 sq. ft. each.

Lumber for 1,000 Sq. Ft.:

98 pieces 1-by-6's, 20 ft. long, dressed to ⅞-in., for floor panels	980 bd. ft.
25 pieces 1-by-6's, 20 ft. long, ribbands and lateral bracing on shores	250 bd. ft.
45 pieces 1-by-6's, 18 ft. long, for ribbands and ledgers	405 bd. ft.
15 pieces 1-by-4's, 14 ft. long, for scabs and braces on jack frames	70 bd. ft.
8 pieces 1¼-by-4's, 12 ft. long, for cleats	48 bd. ft.
34 pieces 2-by-8's, 12 ft. long, for floor panel joist, based on 27-in. spacing	544 bd. ft.
30 pieces 3-by-4's, 14 ft. long, for posts, blocks and jackheads	420 bd. ft.
30 pieces 3-by-4's, 12 ft. long, for reshores	360 bd. ft.
20 pieces 1-by-6's, 20 ft. long, for lateral bracing for reshores	200 bd. ft.
2 pieces 2-by-3's, 16 ft. long, hardwood for reshore wedges, dressed to wedge shape 6 in. long	16 bd. ft.
Total lumber	3,293 bd. ft.
Form lumber per sq. ft. of floor area	3.30 bd. ft.

Other Materials:

8d ordinary wire nails	30 lb.
10d double-headed nails	50 lb.

Labor for 1,000 Sq. Ft.:

Making up floor panels, including repairs, carpenter labor	48 hrs.
Making up jack frames, including repairs, carpenter labor	15 hrs.
Erecting form work, carpenter labor	64 hrs.
Stripping form work, carpenter labor	12 hrs.
Cleaning forms, handling material and hoisting and distributing forms to floor above, common labor	12½ hrs.

Flat Slab Floors

Because of the well standardized relation between the dimensions of a drop panel and the corresponding floor bay, it will be best to include the form work for drop panels along with that for the rest of the floor bay. Consequently the details in Figures 25, 27, 28, 29, 30, 31, 32, 33 and 34 will be used as the basis for this estimate on form work for flat-slab floors.

Floor bays will again be assumed at 20 ft. square, which means that the standard drop panel around the column head will be 7 ft. square. Assume 8 in. as the thickness of the floor slab and 12 in. as the thickness of the drop panel. The story height is assumed as 12 ft. from floor level to floor level, as before.

Lines of 4-by-4 posts supporting the form work, as illustrated in Figures 28 and 29, will be spaced 5 ft. in each direction. Consequently, from Figure 22, it will be seen that the joists for supporting the floor form panels might be 2-by-6's, spaced 20 in. center to center. A more practical combination, however, will be 2-by-8 joists 24 in. center to center, and this is the size and spacing that will be used in the estimate.

Observe that in the form work for flat-slab floors the floor form panels are made up of boards and flat cleats, and are not nailed to the joists. In the case of beam and slab construction (Figures 19 and 20), it will be recalled, the floor form panels were made up of boards and joists.

On the basis of the assumptions made, the form labor and material will now be estimated for 1,000 sq. ft. of floor area, or the equivalent of 2½ floor bays.

Lumber for 1,000 Sq. Ft.:

13 pieces 1-by-6 tongue-and-grooved, 14 ft. long, for panels F1 and F3 (Figure 25)	91 bd. ft.
75 pieces 1-by-8 tongue-and-grooved, 14 ft. long, for panels F1 (Figure 25)	700 bd. ft.
79 pieces 1-by-8 tongue-and-grooved, 8 ft. long, for panels F2 and drop panel (Figures 25 and 30)	421 bd. ft.
24 pieces 1-by-4's, 16 ft. long, for scabs and floor panel cleats	128 bd. ft.
10 pieces 1-by-4's, 14 ft. long, for floor panel cleats	47 bd. ft.
54 pieces 1-by-6's, 16 ft. long, for bracing posts and re-shores	432 bd. ft.
15 pieces 2-by-4's, 16 ft. long, for drop panel cleats and rim	160 bd. ft.
17 pieces 2-by-8's, 16 ft. long, for joists	363 bd. ft.
13 pieces 2-by-8's, 12 ft. long, for joists	208 bd. ft.
5 pieces 3-by-8's, 12 ft. long, for floor joists	120 bd. ft.
10 pieces 3-by-10's, 10 ft. long, for joists under drop panel	250 bd. ft.
38 pieces, 4-by-4's, 12 ft. long, for posts and blocks	608 bd. ft.
13 pieces 6-by-6's, 12 ft. long, for blocks and reshores	468 bd. ft.
10 pieces 4-by-6's, 16 ft. long, for girts	320 bd. ft.
3 pieces 4-by-6's, 12 ft. long, for girts	72 bd. ft.
7 pieces 2-by-3's, 14 ft. long, hardwood for wedges over posts and reshores. dressed to wedge shape 8 in. long	49 bd. ft.
Total lumber	4,437 bd. ft.
Form lumber per sq. ft. of floor area	4.44 bd. ft.

Other Materials:

Van Dorn hangers for 3-by-10 joists	20 req'd
8d ordinary wire nails	40 lb.
10d double-headed nails	8 lb.
12d double-headed nails	4 lb.

Labor for 1,000 Sq. Ft.:

Making up floor panels, including repairs, carpenter labor	48 hrs.
Erecting form work, carpenter labor	64 hrs.
Stripping form work, carpenter labor	12 hrs.
Reshoring, carpenter labor	3 hrs.
Cleaning forms, handling material and hoisting and distributing forms to floor above, common labor	12½ hrs.

Concrete Floor Systems in Steel-Framed Buildings

The type of form work here contemplated is illustrated in Figure 53. The estimate will again be based on a floor area of 1,000 sq. ft.; but instead of separating the beam and girder sides and bottoms from the remaining work, we will assume average beam and girder sizes and estimate all form work over the area assumed.

We will assume a structural frame of the form used in the estimate for form work for girder-beam-and-slab floors, with floor bays 20 ft. square, with main girders in one direction, on each line of columns, and with beams perpendicular to the girders, spaced 6 ft. 8 in. center to center. Assume 20-in. steel I's for the girders and 12-in. steel I's for the beams. On this basis the concrete encasing the beams and girders can have the same dimensions as previously assumed, namely, 12 by 20 in. below the floor slab for the girders, and 10 by 14 in. for the beams.

Material and labor will now be estimated, as stated, for 1,000 sq. ft. of floor area (Figure 52), this area being equivalent to 2½ floor bays.

Lumber for 1,000 Sq. Ft.:

8 pieces 1-by-10's, 20 ft. long, dressed, for beam bottoms	133 bd. ft.
88 pieces 1-by-8's, 20 ft. long, dressed, for floor panels, and for beam and girder sides	1,173 bd. ft.
30 pieces 1-by-6's, 20 ft. long, dressed, for girder sides and bottoms and for beam sides	300 bd. ft.
38 pieces 2-by-6's, 12 ft. long, for floor panel joists	456 bd. ft.
15 pieces 2-by-8's, 20 ft. long for blocking	400 bd. ft.
7 pieces 3-by-4's, 16 ft. long, for 2-ft. crosspieces	112 bd. ft.
Total lumber	2,574 bd. ft.
Form lumber per sq. ft. of floor area	2.58 bd. ft.

Other Materials:

10d ordinary wire nails	40 lb.
6d ordinary wire nails	6 lb.
No. 4 wire	500 lin. ft.

Labor for 1,000 Sq. Ft.:

Making up floor panels, including repairs, carpenter labor	64 hrs.
Erecting form work, carpenter labor	64 hrs.
Stripping forms, carpenter labor	12 hrs.
Cleaning forms, handling material and hoisting and distributing forms to floor above, common labor	12½ hrs.

Walls Above Grade

Walls above grade present themselves in so many different ways that it would be quite impossible to supply an estimate that would apply in all cases. Besides, it is not necessary to do so. This assertion may be substantiated by a reference to Figure 40, showing details of the form work where a wall frames into a wall column or pilaster. This detail, after all, is only a combination of form work for a straight stretch of wall and for a rectangular column. Since columns have been treated elsewhere, the estimates there given can be applied to the column in Figure 40.

Considering these facts, it will be best to make an estimate covering the form work for 1,000 sq. ft. of straight wall, such as the one detailed in Figures 37 and 38. Then, when wall columns or pilasters occur, the form work for those features may be estimated from the previous figures for square or rectangular columns.

Observe from Figures 41 and 42 that the form work area includes door and window openings. Assume a story height of 12 ft., so that the length of the wall considered is 41 ft. 8 in. Also assume 8 in. as the wall thickness and a floor slab 5 in. thick. Assume also that concrete will be placed at the rate of 4 ft. vertically per hour, upon which basis the small table in Figure 37 calls for the waling strips to be spaced 3 ft. vertically and the tie bolts 4 ft. horizontally.

Lumber for 1,000 Sq. Ft.:

100 pieces 1-by-8's, 16 ft. long, dressed, for wall panels	1,067 bd. ft.
6 pieces 1 1/16-by-8's, 16 ft. long, dressed, for false window frames	80 bd. ft.

4 pieces 2-by-2's, 16 ft. long, for spreaders	22 bd. ft.
52 pieces 2-by-6's, 16 ft. long, for double waling strips	832 bd. ft.
24 pieces 3-by-4's, 14 ft. long, for studs	336 bd. ft.
24 pieces 3-by-4's, 12 ft. long, for studs	288 bd. ft.
Total lumber	2,625 bd. ft.
Form lumber per sq. ft. of form area	2.63 bd. ft.

Other Materials:

10d ordinary wire nails	80 lb.
5/8-in. tie bolts, 32 in. long, sq. hd. and nut, with 2 washers to each bolt	66 req'd
Tin sleeves for 5/8-in. bolts (See Figure 38), each 8 in. long	66 req'd

Labor for 1,000 Sq. Ft.:

Making up wall panels, including repairs, carpenter labor	64 hrs.
Erecting form work, carpenter labor	80 hrs.
Stripping forms, carpenter labor	12 hrs.
Cleaning forms, handling material and hoisting and distributing forms to story above, common labor	12½ hrs.

Concrete Stairs

For this item we will assume a stairway in accordance with the layout in Figure 49, assuming further that the stairway is 4 ft. 6 in. wide, the two landings each 4 ft. 6 in. square, the risers 7 in. high and treads 10 in. wide, and the story height is 14 ft. This makes the actual area of contact between the forms and the concrete equal to 230 sq. ft. for each story height of stairway.

The material and labor will therefore be estimated for 400 sq. ft. of form work on a similar stairway, although the estimator can here take account of the probability that salvaged lumber from the other form work will be available by the time the stair forms are built, and that it will not be necessary to buy new lumber for the rough structural parts of stair form construction.

Lumber for 400 Sq. Ft.:

31 pieces 1-by-8's, 14 ft. long, for soffits and landings	290 bd. ft.
36 pieces 1-by-6's, 12 ft. long, for ribbands, scabs, bracing and reshore bracing	216 bd. ft.
14 pieces 1¼-by-4's, 16 ft. long, floor panel cleats	112 bd. ft.
21 pieces 2-by-6's, 12 ft. long, for joists	252 bd. ft.
31 pieces 2-by-8's, 12 ft. long, for stringers and reshore joists	496 bd. ft.
6 pieces 3-by-8's, 12 ft. long, for ledgers	144 bd. ft.
28 pieces 4-by-4's, 14 ft. long, for posts and reshores	523 bd. ft.
14 pieces 1¼-by-8's, 14 ft. long, dressed as detailed (See Figure 52), for risers	196 bd. ft.
Total lumber	2,229 bd. ft.
Form lumber per sq. ft. of form area	5.57 bd. ft.

Other Materials:

20d ordinary spikes	10 lb.
12d ordinary wire nails	10 lb.
10d ordinary wire nails	45 lb.

Labor for 400 Sq. Ft.:

Making up and cutting panels and pieces, including repairs, carpenter labor	60 hrs.
Erecting forms, carpenter labor	12½ hrs.
Stripping forms, carpenter labor	10 hrs.
Cleaning forms, handling material and hoisting forms to flight above, common labor	10 hrs.

Time of Removal of Forms

In a number of previous instances mention has been made of the time that should elapse between concreting and the removal of various parts of form work.

For convenience the previous recommendations on this subject will now be summarized. It should be strictly understood that the periods of time here suggested are intended only for use under favorable weather conditions, during periods of the year when the temperature does not fall below 50 deg. F.

Concrete work may proceed with entire safety during colder periods—in fact, during the entire winter—but during cold weather the materials must be heated and the work must be inclosed so as to maintain a temperature of not less than 50 deg. F. for at least 72 hours after concreting. During this period of the year, small specimen cubes or cylinders of concrete should be made and stored on the job with the regular concrete placed in the structure. Then, before removing forms, the specimens should be placed in a warm room until they attain room temperature, then observed or tested for hardness. If testing facilities are available the actual crushing strength of the specimens should be determined; if not, a blow from a hammer will give some idea of the hardness of the concrete. When struck, there should be a metallic ring to the sound. The following tabulation, as previously stated, gives the time of removal of forms under favorable temperature conditions.

May be removed next day after concreting:

(1) Wall or column footings.
(2) Sills, copings, spandrel beams and various other minor parts that are supported on previously hardened construction.

May be removed in 48 hours:

(1) Foundation walls.
(2) Walls above grade, except in monolithic building construction.
(3) Column sides.

May be removed in 4 to 6 days:

(1) Jack frames and posts under girders, beams, joists and stairs, but not until after reshores (to relieve them) are set in place and tightened.
(2) Beam and girder sides stripped.
(3) Slabs between beams stripped clean (in 4 days if spans are short, in 6 days if spans are long).
(4) Flat slab floor forms stripped, reshores being set in the process.
(5) Beam bottoms stripped, if replaced with short planks at each reshoring post.

May be removed in 6 days:

Walls above grade, in monolithic concrete building construction (but should be left longer, because of curing value of forms).

May be removed in 18 days:

(1) Reshores under girders, beams, joists, and stairs.
(2) Reshores under flat-slab floor construction.
(3) Beam and girder bottoms, when left in place with reshores.

Removal of form work of parts of a structure not specifically mentioned above should be guided by the stripping schedule for parts of a similar nature that are mentioned.

Winter Construction Makes Full Year for Contractor

Many Evils of Winter Shut-Down—Avoiding Fluctuations in Building Volume—How Concrete is Protected—Heating Aggregates and Water

THE first signs of winter have long been the signal for the concrete contracting industry to cease operations and take a four-month "vacation." To the contractor, this four months of idleness means depreciation of equipment; it means disbanding of construction crews and a complete seasonal turnover of labor; it means a fluctuating business volume; it means lost jobs during the peak season because of inability to handle them on account of labor and material shortage; it means increased labor rates during summer. In very simple language, winter idleness is most unprofitable.

A typical example of canvas protection in winter construction

Placing concrete at 15 below zero. The floor is covered with hay and the basement heated

Winter Shut-Downs Unnecessary

That the annual shut-down of building operations is unnecessary is evidenced by the fact that fewer and fewer concrete contractors stop work in cold weather. The ever-increasing amount of winter construction successfully carried on in many of the larger cities throughout the northern regions of the country is good evidence of this fact. It has been proved, time without number, that concrete work can be carried on just as safely in the winter as in the summer. The slight additional cost of providing adequate protection against low temperatures in the winter is often more than offset by advantages, both monetary and physical, afforded by an unbroken construction season.

Many Advantages in Full Year Season

The many advantages to the concrete contractor of a 12-month construction season hardly need mentioning. In brief, it does away with all of the evils listed in the first paragraph. Most important of all, an all-year construction season tends to provide uniform business the year 'round. The contractor can take on more jobs over a year's period than is possible if he works only eight months.

The owner likewise benefits from having his work done in the winter. In the first place, he secures earlier use or profit-taking, as the case may be, on the structure. This is a particularly potent factor in the case of structures to be used by the public or in residences to be ready for spring occupancy. Second, materials and labor are secured during a low period in the market and, consequently, savings can be made in both. Third, by having the work done in the winter when business is not rushing, a better job usually results. These are general advantages that apply to practically all jobs done in the winter. Particular types of work will often offer even further advantages.

Keep Temperature Above 60 Degrees

The general principle to be remembered in winter concrete is that heat hastens the hardening of concrete, while cold retards it. At about 80 degrees Fahrenheit concrete hardens rapidly. Below this temperature the rate of hardening decreases. When the temperature is around 50 degrees the process of hardening is quite slow and at freezing it ceases entirely. If concrete is kept at a temperature of 60 degrees or higher it soon hardens sufficiently to be safe against damage by frost. The warmer it is kept the sooner will it reach this degree of hardness. The general opinion is that 72 hours is sufficient if the concrete can be kept above 60 degrees, but it is better to protect the concrete from freezing for about a week.

How Concrete Is Protected

When freezing occurs only at night, the only precaution necessary is to cover the concrete to protect it from the frost. Floors, walks and pavements may be covered with paper and a 10 or 12-inch layer of hay or straw placed on the paper with another layer of canvas in case the frost is severe or the wind is likely to blow the covering off. Outside walls and foundations can be protected by coverings of canvas or straw, or by building inclosures around them and heating the interior with oil stoves, coke stoves, commonly known as salamanders, or some other form of stove which will provide considerable heat without smoke.

Heating Aggregates and Water

As the weather becomes colder it may be necessary to heat the materials with which the concrete is made.

To heat the aggregate they may be banked over an old culvert pipe, a section of smoke-stack or some other improvised heater and fire kindled inside to thaw them out or warm them sufficiently to keep the frost out until they have been mixed and the concrete has time to set. A satisfactory heater can be made by building a firebox of concrete block or brick with a sheet iron cover on which the aggregates are piled. Sand and pebbles are heated separately to prevent them from becoming mixed. They should be raked over frequently so that all frost and ice is thawed out before using. On large jobs it is customary to use perforated steam pipes for heating materials. Cement need not be heated.

Mixing water likewise should be heated—the warmer the better, but it should not be boiling. Water can be heated over a fire in tanks or kettles or by blowing steam into it.

Before placing the concrete, frost, snow and ice must be removed from the forms. The concrete should be placed in the forms immediately after it is mixed to prevent loss of heat. As soon as the concrete has been placed it should be protected to retain as much heat as possible.

Too early removal of forms must be carefully guarded against. Frozen concrete is frequently mistaken for properly hardened concrete, because it has the same "ring" when struck with a hammer. A reliable test is to apply heat or hot water to the surface. If the concrete is frozen it will turn soft on thawing.

Paving Contracts Up in November

Figures Indicate Final Totals on Paving Awards in 1930 Will Exceed 1929 Yardage—General Construction in Moderate Volume

Concrete highway paving contracts awarded in November exceeded the contracts in November, 1929, by more than a million and a half square yards, and November combined contracts for concrete roads, streets and alleys bettered the 1929 record by a million square yards.

This fine showing in November brings the total concrete paving awards for the first eleven months of 1930 to 137,011,888 sq. yd., within striking distance of the 140,020,751 sq. yd. awarded in the full year of 1929. The awards in the first eleven months of 1929 totaled 132,201,513 sq. yd. In concrete roads alone the awards for the first eleven months of 1930 exceeded the awards in the corresponding period of 1929 by 15,414,207 sq. yd.

The large yardage awarded in November makes it reasonably certain that 1930 concrete paving contracts will exceed the awards of 1929 by several million square yards. November contracts, as reported by the Portland Cement Association, are as follows:

SQ. YD. OF CONCRETE PAVEMENTS IN NOVEMBER

	1929	1930
Roads	3,207,275	4,790,288
Streets	1,721,705	1,371,475
Alleys	428,639	130,989
Total	5,357,619	6,292,752

General construction contracts in the 37 states east of the Rocky Mountains were reported by the F. W. Dodge Corporation as continuing at a moderate pace, new residential building construction having been maintained at a fair volume. The figures reported by the Dodge organization follow:

CONSTRUCTION CONTRACTS IN NOVEMBER

	1929	1930
Buildings	$318,651,400	$181,877,900
Public works and public utilities	72,361,100	71,695,800
Totals	$391,012,500	$253,573,700

Total construction contracts awarded in the first eleven months of 1930 amounted to $4,275,598,600, compared with $5,455,182,400 in the first eleven months of 1929.

International Congress Adopts Report Affecting Concrete Roads

Conclusions Recognize Position of Concrete as Major Road Building Material—Congress Discusses All Types of Road and Pavement Design, Construction and Maintenance

THE Sixth International Road Congress, which convened in Washington, D. C., during the week of October 6 to 11, 1930, discussed all phases of highway design, construction, and maintenance, the financing of highways, highway transportation, traffic regulations and kindred subjects.

The agenda of the congress comprised six major questions. Each question had been assigned well in advance of the congress to a separate committee, designated as general reporters. The various papers, or reports, prepared by these committees were presented to the congress on Monday, October 6th, and were considered and debated in a number of section meetings during the three days following. In these section meetings the conclusions suggested by the general reporters were discussed, and various revisions and amendments were offered.

The conclusions reached their final form in the section meetings of October 9, and were submitted to the plenary session of the congress on Friday, October 10.

Interesting Conclusions on Concrete Roads

The first question on the agenda of the congress was designated as "Question 1-A: Results Obtained by the Use of Cement." Another question, designated as 1-B, dealt with brick paving. The five remaining questions were concerned with various other paving and road construction materials and methods and with financing, highway transport, and other matters not definitely related to design or construction.

In consequence, only the conclusions pertaining to concrete pavements will be given, in the fifteen numbered paragraphs that follow:

1. Cement is becoming generally used as a paving material and has many inherent advantages. Rapid-hardening cement has special advantages in particular circumstances.

2. Cement has been used successfully in the construction of cement concrete base courses for other surfaces, for cement concrete pavements, and for cement-bound macadam.

3. Cement concrete pavements and also cement concrete base courses protected by appropriate wearing surfaces are suited to heavy traffic.

4. Where a large volume of steel-tired traffic is encountered, if cement concrete is adopted as a pavement material, a 2-course pavement with the upper layer composed of very hard aggregates should be used instead of a single-course pavement.

5. Single-course pavements have successfully carried maximum volumes of traffic and maximum wheel loads when the traffic was largely rubber tired.

6. Cement-bound macadam has been successful on roads carrying light traffic not inimical to the macadam type of construction. This method seems especially advantageous in locations where the condition of drainage or exposure are unfavorable to the use of ordinary water-bound macadam. A protective wearing surface seems equally indispensable on cement-bound and water-bound macadam.

7. In designing cement concrete pavements and cement concrete base courses to be surfaced with other materials the resulting pavements should have equal load-carrying capacity or structural strength, when similar traffic conditions are to be met.

8. Competent engineering supervision of design, construction, and maintenance of cement concrete pavements is necessary to insure good results.

9. It is desirable that subgrades be uniform and stable.

10. Pavement slabs must be designed to carry expected loads. Edge thickening is advantageous as a means of producing an economic and balanced structural design for concrete pavement slabs.

11. Longitudinal and transverse joints are commonly used and must be designed to meet traffic, subgrade, climatic conditions, and shrinkage of concrete, but in view of the fact that a number of concrete roads have been successfully constructed without joints, it is advisable that further research should be made on the whole subject of joints and cracks.

12. Scientific design of concrete mixes and weight proportioning of aggregates represent the most modern practice.

13. Construction operations are performed mostly by machinery, with resulting lower cost and better workmanship. The value of a cement concrete roadway depends to a large extent on the perfect execution of the work and, in particular, on the homogeneity of the concrete.

14. Thorough curing of concrete surfaces is essential.

15. Maintenance of concrete surfaces, properly constructed, is relatively simple and reasonable in cost. In particular, maintenance should comprise immediate filling with suitable material of the expansion joints and of any cracks which may occur.

The above conclusions were reached after full discussion of the report, mentioned elsewhere in this issue, presented by Frank T. Sheets, Roy W. Crum, E. M. Fleming, Arthur N. Johnson, Clifford Older and Raymond E. Toms.

Contracting Company Specializes in Concrete Form Erection

Profitable Field Suggested for Sub-Contracting Business —Taking Load from General Contractor—Tulsa Company Builds Special Form System Developed by Architect

SPECIALIZING in concrete form erection and taking sub-contracts for such work has possibilities in every city of sufficient size to support a steady volume of construction work. At the present time the field for this activity is principally in the larger buildings; but with the spread of the idea of concrete first floors for dwelling houses the field will be increased.

Take Load from General Contractor

The sub-contractor who specializes in concrete form work is in a position to take over the work which many general contractors consider the most troublesome part of concrete construction and the most difficult to figure. This is true especially with the general contractor who has had only limited experience in the erection of important reinforced concrete structures.

The Economy Removable Form Company, of Tulsa, Okla., has demonstrated the possibilities of specializing in form erection. This organization has built the forms on seventeen large concrete buildings and a number of smaller ones in that city. While the company utilizes a special form system developed and patented by John T. Blair, a Tulsa architect, the fact remains that they are primarily in the business of taking sub-contracts for form work. The patents protect them in the use of the special details and methods developed. These details and methods involve certain economies in form work which constitute an additional aid in winning profitable contracts.

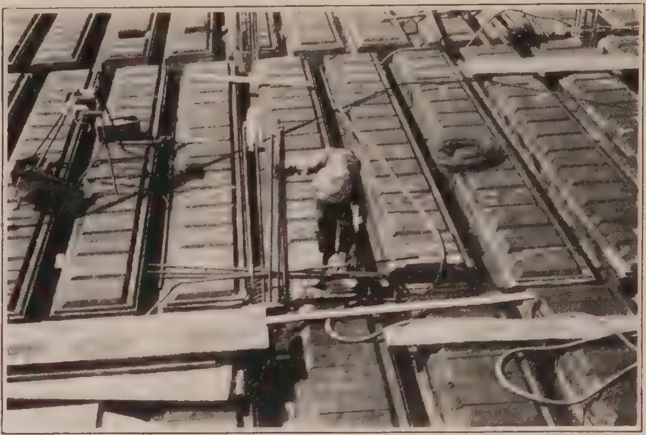

Figure 2. Installation of form work for joisted and paneled ceiling

Special Methods and Details

Some of the special features of the form system em-

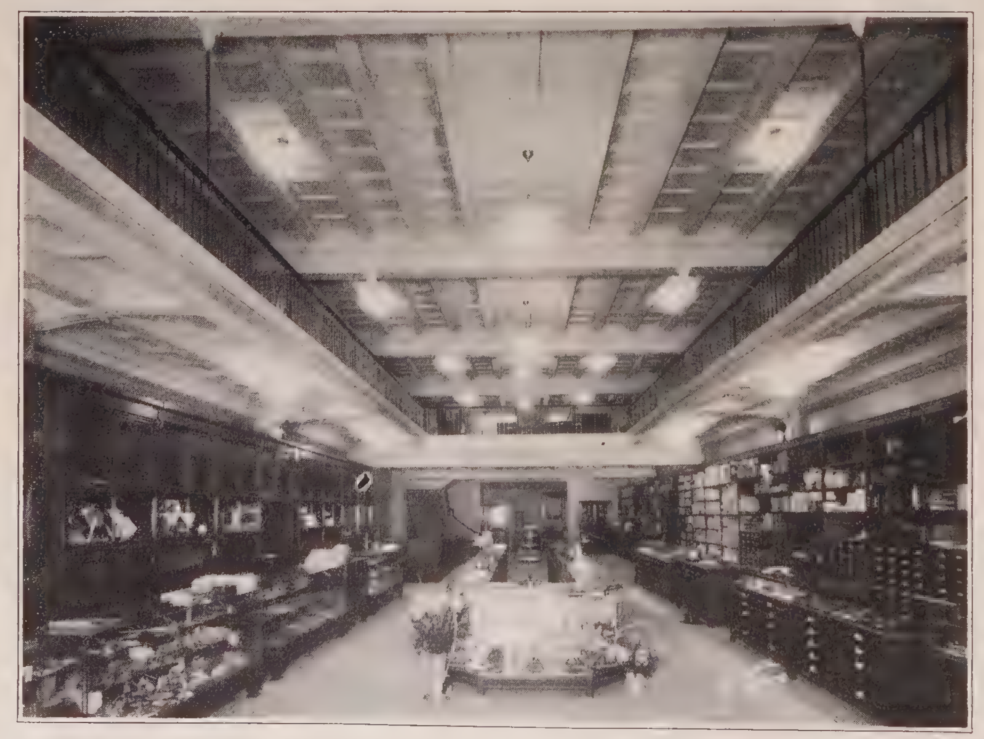

Figure 1. Joisted and paneled ceiling molded in concrete

ployed by the Tulsa company will now be described. These features illustrate the advantages of developing special methods and details, whether they are patented or not. In either case the form work sub-contractor gains by the greater economy which his special methods make possible.

Form Work Produces Paneled Ceilings

One of the features of the concrete form system developed by Mr. Blair is seen in the paneled ceilings which it forms. The panel effect is well illustrated in Figure 1, showing the interior of the building occupied by the Fields Stationery Company, of Tulsa. After the forms were removed the only additional treatment given to the ceiling was a slight stipple dash of lime and moulders' plaster applied directly to the concrete surface. This method of treatment had the very practical advantage of eliminating the need for lathing and plastering the ceiling, besides reducing the dead weight of the floor construction.

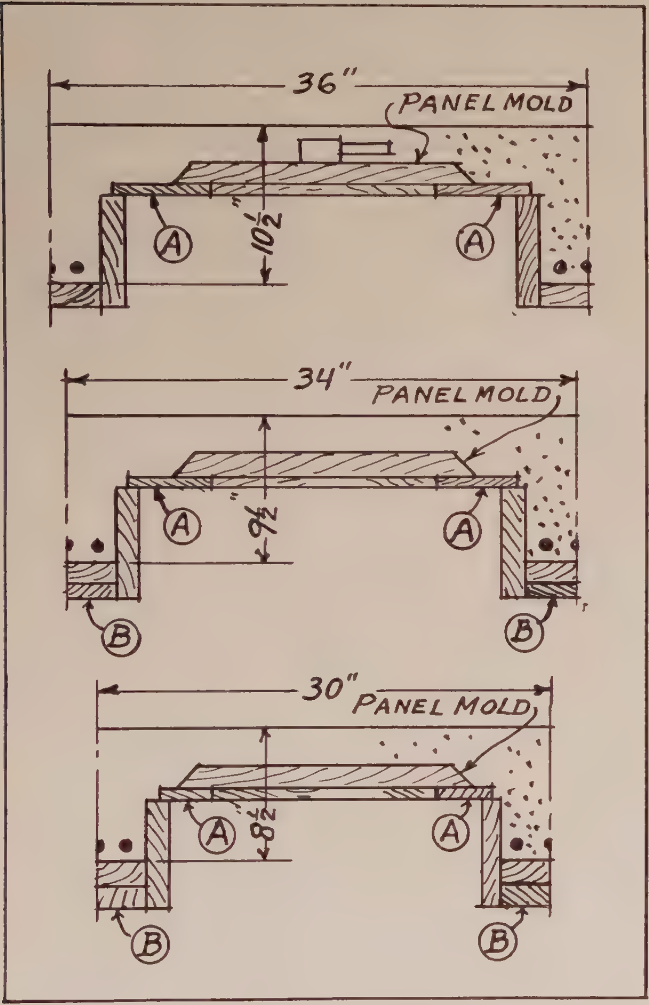

Figure 3. Details showing adjustments for varying widths and depths

An installation of form work, including the pans required to form a paneled ceiling, is shown in Figure 2. This was in the Duffey Building, in Tulsa. The finished result will be similar to that in Figure 1, panels being formed in the ceiling between joists.

The flexibility of this form work may be understood by a study of Figure 3, which shows the forms for the type of ceiling illustrated in Figures 1 and 2. Here it is seen how the same forms may be used for joists of different depth and different spacing. For instance, the same joist sides, bottoms and pans are used to produce joists 10½ in. deep and 36 in. center to center; or 9½ in. deep and 34 in. center to center; or 8½ in. deep and 30 in. center to center.

Adjustments for the width are made by slide "A," which is made of different widths according to the requirements of each case. This adjustment of width by means of strips of different widths is similar in principle to the method employed with forms for columns of different size, described on page 20 of the February (1930) issue of CONCRETE.

The variations in depth are accomplished by nailing small blocks of either 1-in. or 2-in. material on the supporting form joists, directly under the dressed planks that form the bottoms of the concrete joists. These blocks are shown at the points marked "B" in Figure 3.

Panels in Flat-Slab Ceilings

Similar pans may be used in forming paneled ceilings in flat-slab construction. Here again the form units may be adjusted for different widths. The supporting form joists are placed as required for any flat-slab construction,[1] and dressed bottom planks are placed on the form joists to support the edges of the pans. Differences in span length are taken up by varying the space between pans.

The pans used to form the ceiling panels are made in standard size from 2-in. stock, dressed and planed to a mold 20½ in. square and 1⅝ in. deep.

Aside from the buildings mentioned, similar forms were used in the construction of Marquette High School, the Edgar Music Company Building, and a number of others of both large and small size.

Gherardi and Chapman Head American Standards Association

The election of Bancroft Gherardi, vice-president and chief engineer of the American Telephone and Telegraph Company, to the presidency of the American Standards Association was announced at the annual meeting of the association at the Hotel Astor, New York, December 11. Mr. Gherardi, who has been a member of the association's board of directors, will assume the direction of the national and international standardization activities of the organization.

Cloyd M. Chapman, engineering specialist of New York City, was re-elected to the vice-presidency of the association for the year 1931.

American Society of Municipal Improvements Changes Name

The American Society of Municipal Improvements, 4359 Lindell Boulevard, St. Louis, Mo., has changed the name of the organization to American Society of Municipal Engineers. C. W. S. Sammelman is secretary of the society.

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[1] See May, 1930, issue of CONCRETE, pages 35-39.

HOW TO DO IT

✦ **Questions and Answers** ✦
Consultation and Comment

A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

Oil for Forms and Molds

What kinds of oil are suitable for oiling pressed steel forms for casting concrete silo staves? I would also appreciate having the names of manufacturers supplying such oil.

Where greases, lard, paraffin or fuel oils are used, what formulas are followed in mixing them?—H. C. W., Syracuse, N. Y.

One company has placed a concrete form oil on the market which is described as non-staining. Standard form oils are also supplied by several of the large oil companies. Still another company makes nozzles for those who claim that spraying the forms is more economical than brushing them. A list of these companies has been sent you.

In regard to formulas for mixing form oils, there seems to be no definite standard. Steam lubricating oil is very commonly used after being "cut" with kerosene. The density of the lubricating oil varies in different communities and in different shops, and the amount of kerosene to be used must of necessity be varied with the density of the oil. The actual proportion of kerosene required must be determined by experiment in each case.

Paraffin oil is also commonly used, and lard oil is used by some. These must likewise be "cut" with kerosene, the actual quantity of kerosene being found from experiment.

Small Mixer for Laboratory Work

We are looking for a small electrically-driven concrete mixer, having a capacity of 2 or 3 cu. ft., for use in laboratory work. Can you give us the names and addresses of a few manufacturers that make them?—B. E. R., Austin, Tex.

Several concrete machinery manufacturers, whose names and addresses are being sent to you, make a small mixer of the kind you describe.

Light-Weight Aggregates on Market

I would like to know if there is any light-weight aggregate on the market that is suitable for concrete back-up units, aside from cinders, pottsco and haydite.—M. A. R., Milwaukee, Wis.

Several other kinds of light-weight aggregate are either available or under development in various sections; but so far as the territory within shipping distance of Milwaukee is concerned we do not know of any other that is being marketed commercially.

You are, of course, familiar with the several forms of cinder aggregates available in your territory, some washed or treated and others used as they come from the furnaces.

You are doubtless familiar, too, with the use of crushed blast-furnace slag as a concrete aggregate for both fine and coarse materials. The weight of crushed slag ranges all the way from 60 to 100 lb. per cu. ft. You might be fortunate enough to find one of the lighter grades available, which should produce units sufficiently light and strong for back-up purposes.

Design of Concrete Tanks and Swimming Pools

I am interested in the simplified formulas for reinforced concrete design, published in CONCRETE. *Have you published formulas for the design of concrete tanks and swimming pools? —B. C., Jackson Heights, Long Island, N. Y.*

Simple formulas for the design of circular and rectangular reinforced concrete tanks for the storage of dry materials were published on pages 43-44 of the June (1928) issue of CONCRETE. Formulas for the design of reinforced concrete water tanks will be found in standard textbooks and handbooks, such as several of the publications carried by the Book Department of CONCRETE.

No formulas for the design of swimming pools have been published, for the reason that swimming pools do not constitute a special case. The walls of the pool are designed as retaining walls, but two conditions must be assumed. First, when the pool is filled with water the wall must be reinforced to resist the outward water pressure. Second, when the pool is empty the wall must be designed to resist the earth pressure from the outside.

Reddish Brown Cement Colors

I am in need of cement colors that will produce a reddish brown concrete. On attempting to buy it I find that dealers have many different kinds, and they are unable to advise me on the subject. Can you recommend a color for this purpose?—S. A. N., Vancouver, B. C.

The colors used should, first of all, be mineral colors, because in only a few instances have organic colors been found satisfactory.

For a rich reddish brown effect, a writer in the December (1930) Cement Mill Section of CONCRETE recommends the following formula:

	Parts
Portland cement	88
Manganese dioxide	4
Ferric oxide	6
Ferroso-ferric oxide	2
Total	100

The three coloring agents should first be mixed together while in a perfectly dry condition, then added to the cement. The mixing of the colors, as well as the mixing of the combined colors and the cement, must be extremely thorough if streaky work is to be avoided.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.
Annual convention, Feb. 24-26, Hotel Schroeder, Milwaukee, Wis.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Road Builders' Association; Chas. Upham, Engineer-Director, 914 National Press Building, Washington, D. C.
Annual convention and road show, Jan. 10-17, Jefferson Hotel and Arena, St. Louis, Mo.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; E. J. Harding, Assistant General Manager, 1150 Munsey Bldg., Washington, D. C.

Cast Stone Institute; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Cement Institute; Luther G. McConnell, General Manager, 11 East 44th St., New York City.

Concrete Masonry Association; Jack Franklin, Secretary, 7071 Plankinton Bldg., Milwaukee, Wisconsin.
Annual convention, Feb. 23-26, Hotel Schroeder, Milwaukee, Wis.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Joint Committee on Standard Specifications for Concrete and Reinforced Concrete; F. R. McMillan, Secretary, 33 W. Grand Ave., Chicago.

National Board of Fire Underwriters; W. E. Mallalieu, General Manager, 85 John St., New York City.

National Concrete Burial Vault Association; J. H. Stuart, Secretary-Treasurer, Bremen, Ohio.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.
Fourteenth annual convention, January 19-22, St. Louis, Mo.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Lime Association; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

National Ready-Mixed Concrete Association; Headquarters, 27 Barbeau Street, Pittsburgh, Pa.
Annual convention, Jan. 26, Hotel Jefferson, St. Louis, Mo.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.
Annual convention, January 27-29, Hotel Jefferson, St. Louis, Mo.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Building, Cleveland, Ohio.

National Terrazzo and Mosaic Association; U. F. Durner, Secretary, 809 St. Paul Ave., Milwaukee, Wis.

Northwest Concrete Products Association; W. P. Hews, Secretary-Treasurer, Yakima, Wash.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 425 East Water St., Milwaukee, Wisconsin.
Annual convention, February 23-26, Hotel Schroeder, Milwaukee.

The Concrete Industry —25 YEARS AGO

THE January, 1906, issue of CONCRETE has as its initial article one on the portland cement plants of the Middle West. Most of the eight plants described are recognizable by their locations, only one being known under its present name and ownership.

* * *

A SUMMARY of structures in Cincinnati, where "concrete is king," is continued in a short article. Twenty large buildings, all of reinforced concrete construction, are under way, among them those for the Cincinnati Southern Railway, Bullock Electric Company, and the Union Savings and Trust building.

* * *

NEWS notes from Iowa refer to the organization of the Iowa Enamel Stone Company at Des Moines "for the purpose of manufacturing polished cement, brick, tile, etc.," and the filling of a recent large order by the Sibley Cement Walk, Block and Tile Company, at Sibley.

* * *

"IN the operation of a concrete block plant there will continually develop new ideas for making of molds and of ornamental blocks, and the man who is always on the alert to adopt new ideas which will assist him in turning out varied designs of blocks will be the one to succeed in the business," according to H. G. Richey, in the January, 1906, issue of *Cement Age.*

* * *

HARRISON ALBRIGHT, architect, pays tribute to concrete as a material, at the same time pointing out "some of the stumbling blocks which the beginner is apt to meet with in his efforts in reinforced concrete construction."

* * *

THE extensive concrete work under way on the New York Short Line of the Philadelphia and Reading System is described and illustrated in a 5-page article. Twelve new bridges on the new line, four bridges on the connecting roads, and numerous culverts are involved.

The most important structure is the Neshaminy Creek bridge, constructed of concrete without reinforcement, with six arches. It is 57 feet wide and designed to carry four tracks.

"The foundations are concrete mixed 1, 3, and 6 cement, sand and 2½ stone, tamped into rough forms. The arches spring from a point about 17 feet above the top of the foundations and are semi-circular. From the top of the foundations up, a 1:2:4 mixture of cement, sand and stone was used, the stone being of a size that would pass through a 1½-inch ring."

* * *

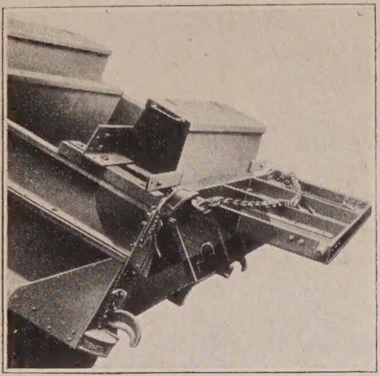
THE first edition of the book, "Concrete, Plain and Reinforced," by Frederick W. Taylor, M.E., and Sanford E. Thompson, C.E., is reviewed.

The authors, in the opinion of the reviewer, "have covered the field most fully; have delved more deeply into literature on the subject than most of those who have gone before, and have gathered into their single volume more information on the subject in all its branches, than has hitherto been presented in a public way, in any single publication."

New Equipment and Materials

Cementank New Highway Equipment by Blaw-Knox

The Cementank is a new Blaw-Knox product which will be introduced to the construction industry at the forthcoming St. Louis road show. The Cementank is a steel cement container for batch trucks on highway paving or other work where the cement is proportioned into compartment trucks at a central plant, and then hauled to the paver or mixer.



It is welded steel construction, moistureproof, equipped with a hinged top cover and a discharge door which opens automatically when the compartment is dumped. The Cementank requires absolutely no attention on the part of the operator, and the cement empties by gravity and flows with the aggregates into the skip of the mixer, it is stated. Arching of cement is prevented by the shape of the tank and its method of discharge.

The discharge door is flashed with felt to prevent leakage of cement. Locking of the end gate or truck partition automatically locks the discharge door of the Cementank. It has a capacity of 10.35 cu. ft.—ample to take care of a 7-bag batch.

Metal-Faced Concrete Blocks and Slabs Made by "Macotta" Process

"Macotta" is the trade name of a protected light-weight concrete building unit having a weather-proof and permanent surface of metal. It is used for exterior or interior building trimmings, spandrels, frieze courses and the entire surfaces of buildings.

Macotta can be developed from any commercial metal, such as copper, brass, bronze, lead, zinc, aluminum, Allegheny metal, monel, nickel, iron, tin and composite alloys of them. Plain areas can be of different metals and can be oxidized to produce almost any desired color effects, it is claimed.

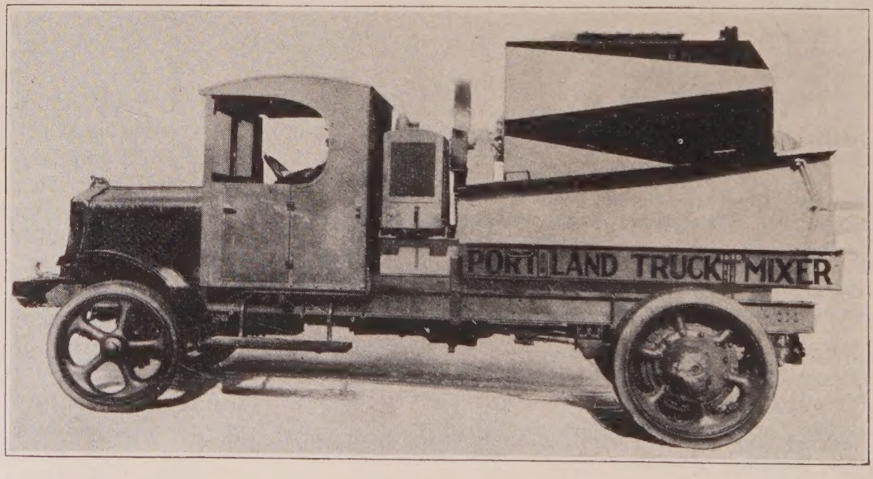
The material weighs about 100 pounds to the cubic foot and is said to have high insulating qualities. It may be used as a solid wall unit, as its inner side forms an acceptable plaster base.

Macotta complies with the strength requirements of local and state building codes, and has great fire resisting qualities, according to the Maul Company, of Chicago and Detroit, who are the exclusive manufacturers.

Design of Body and Openings Features of Portland Truck Mixer

Vanes, fins or other internal attachments are entirely absent from the new Portland truck mixer for either mixing concrete en route or transporting it already mixed. The shape, with offset hexagonal heads and triangular panels sloping alternately forward and back, is designed to keep the contents thoroughly mixed and retain plasticity and workability of the concrete for more than three hours.

The loading and discharge openings are large and easily operated, it is said, and the outward flow of concrete is controlled by toggle-operated butterfly doors.



The unit is separately powered by a 7½-12 hp. 4 cylinder LeRoi engine, and is equipped with a stub chute discharging up to 43 in. above grade, and a one-piece swiveling extension chute.

When desired, a flanged, removable top section is provided so that the drum can be used as an ordinary dump body as well as a concrete carrier and mixer.

The three-yard size is now available, and the five-yard model is forthcoming, the Portland Concrete Machines Company, Cleveland, Ohio, announces.

New Dial-Scale Weigh Hopper for Bucket Loader

A new dial-scale weigh hopper designed to weigh within .4 of 1 per cent of absolute accuracy even while the bucket loader on which it is mounted is operating at an angle of 4 deg. has been released by the Barber-Greene Co. of Aurora, Ill. It is used with the newly announced Model 62 Super Bucket Loader, a crawler-mounted, self-feeding, one-man operated machine with a capacity of 62 cubic feet per minute.

The weighing unit built into this hopper is an American Kron Scale. The dial on the scale is graduated into two-pound units and is provided with two markers which may be set to indicate the desired reading. Directly above the weigh hopper is a small auxiliary hopper holding approximately 360 pounds of material.

The weigh hopper will weigh batches up to 3600 lbs. not to exceed 32 cubic feet in volume, it is said.

The loader on which this weigh hopper is mounted is the new Barber-Greene Model 62 Super Bucket Loader. This machine has all the standard features of any Barber-Greene loader with some new features of its own. It has, in addition to the standard Overload Release Sprocket for protection to the machine against strains due to an overload on the bucket line, an overload release sprocket on the crawler drive to protect the machinery there.

C. S. Johnson to Introduce New Multiple Material Weigh Batcher

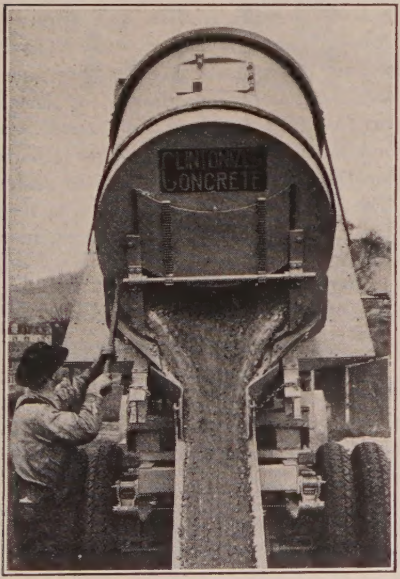
A new multiple material weigh batcher designed especially for paving contractors will be exhibited at the American Road Builders' show at St. Louis, by the C. S. Johnson Company of Champaign, Illinois, in Space No. 24 in the arena. The batcher is constructed to handle three aggregates and is divided into three compartments, the weight of each compartment being controlled by a separate beam which eliminates any adjustment after the beams are once set.

The exhibit will also include the improved bantam weigh batcher, a new bulk cement handling cart, and standard single material weigh batchers for sand and stone.

C. S. Johnson, J. C. McLean, and K. H. Melzer will represent the company at the show.

New Type of Conveyor-Conditioner for Ready-Mixed Concrete

A new and improved type of the Clinton conveyor-conditioner, for hauling ready-mixed concrete, is announced by the Clinton Motors Corporation, Reading, Pa. It is known as Type 2.



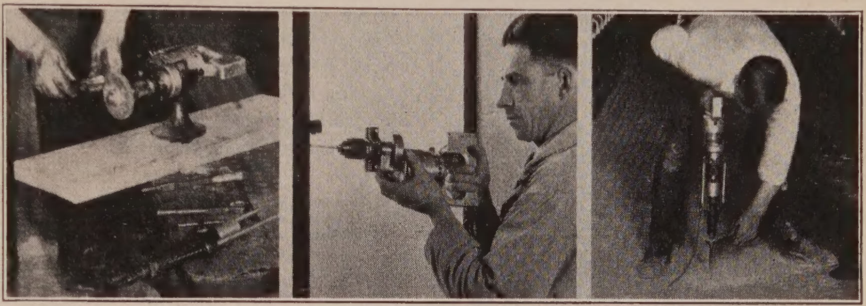
In the Clinton conditioning process, the concrete is sealed in a cylindrical tank having no internal blades or paddles, and the tank is rotated while in transit. An air space at the top causes the plastic mass to flow constantly toward the low side as the tank turns, and this "rolling-over" action brings all parts of the mass in succession to the top, it is stated. Thus the air bubbles churned in by the mixer blades are allowed to escape resulting in a dense concrete of high strength for the proportions used.

In the new Type 2, the trunnion bearing formerly used at the rear of the tank is omitted, and the rear is supported by rollers bearing against a steel rim welded to the tank. This change permits the discharge door to be considerably enlarged.

With the enlarged door, even a stiff mixture is discharged rapidly. The makers say that the new-type conveyor will discharge concrete mixtures of any slump.

New Wodack Twist and Hammer Drill Announced

The Wodack electric dual twist and hammer drill is designed to bore into wood, metal and masonry, making holes up to ⅞ in. diameter. One minute is said to be required to drill a 9/16-in. hole 3 inches deep in concrete. It may also be used for grinding, scratching or buffing.



The tool, weighing twelve pounds, is furnished in a metal carrying case with star drills and twist drills.

Vibration Applied to Down-Face Block-Making Machines

J. D. Abram, said to be the inventor and patentee of the down-face stripping principle in block-making machines, now announces another innovation in the concrete products industry for which startling results are claimed. It is said to promise great improvement in several important details that are now being given much consideration by the industry.

The invention as applied to the block machines of the down-face type, is a simple, effective device for vibrating the face plate of the machine at a very high frequency after the facing material has been deposited on it, the effect of which draws the cement paste from the material to the face plate. That portion of the material in immediate contact with the face plate is liquefied, spreading a thin solidified film over the entire face of the block. The blocks, made of ordinary run of mixtures, are filmed on the face with a coating that is waterproof and at the same time brought to a smoother finish than is possible under existing methods.

It is possible to produce tints and blends in an inexhaustible number of designs, in imitation marble, travertine stone and random colors, according to Mr. Abrams.

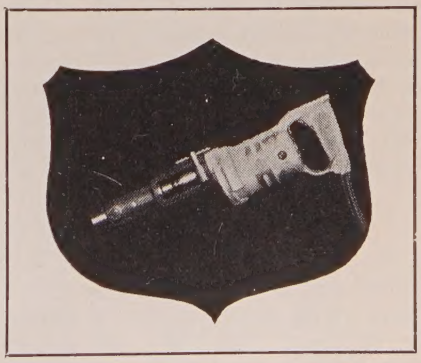
This is accomplished by the use of a matrix or intervening false plate between the regular face plate and the material to be molded.

To bring about the most desirable results in blending colors and waterproofing the face of blocks, the facing material is mixed wet enough to quake and run under vibration. Under the action of the vibrator this wet mixture settles and adheres closely to the bottom plate. The suction created would make it possible to remove only plain blocks from the plate, so the original purpose of this intervening matrix was merely to provide a shield to prevent the wet facing adhering to the plate. This purpose accomplished, however, these matrices were designed not only of stainless steel, but of paper and rubber as well.

Faces of fine herringbone, imitation fabric, diamond, squared and other designs have been produced on the rubber matrices, the vibrating process insuring full and complete filling of the matrix design regardless of its design or texture. The matrix itself remains on the green block until the initial set, when it is removed and used again.

Combination Tool for Wood and Concrete

The hammer drill shown below is a new combination tool that hammers, drills and grinds. Holes up to 1 in. in diameter can



be hammered in concrete or holes up to 5/16 in. diameter can be drilled in wood, according to the Milwaukee Electric Tool Corporation, Milwaukee, Wis.

A detailed description of the tool will be found on Page 51 of the December issue of Concrete.

About Makers of Equipment and Materials

Notes From the Field

Collins Joins Consolidated

The Consolidated Concrete Machinery Corporation announces that it has obtained as its sales promotion manager, *D. R. Collins,* known to the concrete products manufacturers as "Spec." Mr. Collins has already assumed his duties with the Consolidated company, having its factory and office at Adrian, Michigan.

Mr. Collins was discharged from the army in 1919 and accepted a position with the Portland Cement Association in its Cement Products Bureau. During that time he covered the greatest share of the United States, working with concrete products manufacturers to help them improve the quality of their product and extend their market.

The three and one-half years Mr. Collins spent as an active manufacturer of concrete products, he acted as manager of an old established plant.

For the past year and a half, he has been handling the sales of twenty-one concrete block manufacturers in and around the City of Milwaukee.

For the past six years, he has been extremely active in concrete products association affairs and has the record of the only man who held every available office in the National Concrete Products Association, now known as the Concrete Masonry Association. At the time of his employment by the Consolidated company, he was president of that organization and has spent a great deal of time in working out the proposed five-year program which that association is now operating under. He was also at that time president of the Wisconsin Concrete Products Association, an organization which he helped organize in 1922 and in whose work he has been active since that time. He has resigned both offices, to be able to give his full attention to his new work.

Butler Bin Exposition

The Butler Bin Co., of Waukesha, Wisconsin, have been assigned in the Arena, space AR-16, during the 1931 road show at St. Louis. There they will display their latest type of contractors' portable bin, equipped with a new and improved weighing hopper.

There will also be shown a road contractors' portable bulk cement handling plant, the balance of the exhibit consisting of a motion picture taken in the field, and several small models of aggregate proportioning equipment. A considerable portion of the exhibit will be devoted to central mixing plants with new bulletins, layouts, etc.

Heltzel Display

The Heltzel Steel Form and Iron Co., Warren, Ohio, will occupy Booth AR-12 at the road show to be held at St. Louis in January, and will exhibit its complete line of concrete road building equipment. This comprises a 3-compartment portable storage bin equipped with a 3-compartment weighing batcher, and steel forms. A flexible joint machine and numerous small tools will also be on display.

Link-Belt Exhibit

Link-Belt Company, Chicago, will exhibit at the following St. Louis conventions:

National Crushed Stone show, January 19-22; National Ready Mixed Concrete Association convention, January 26; National Sand & Gravel convention, January 27-29.

New Dunbrik Plant

The organization of a new enterprise for the manufacture of *Dunbrik* has just been completed at Muskegon by the Stonecraft Company of Grand Rapids, in company with the P. J. Connell Company and other leading building supply dealers in western Michigan. The new organization will be known as the Muskegon Dunbrik Company.

The construction of an up-to-date plant, with a capacity of 24,000 units per day, has already begun. Building plans, specially designed for the efficient production of this new brick building unit, are under the supervision of the engineering department of the *W. E. Dunn Mfg. Co.,* Holland, Mich.

American Steel & Wire Exhibit

The American Steel & Wire Company will occupy Space No. A-73 at the St. Louis road show, and will exhibit wire reinforcing fabric, triangle mesh and electric weld, for the reinforcing of roads and streets, steel posts, wire rope, and guard rail.

Blaw-Knox Road Exhibit

The following is some of the equipment that will be exhibited by the *Blaw-Knox Company,* Pittsburgh, at the coming road show at St. Louis: Portable bulk cement plant, Cementank, weighing batchers, road form, agitator truck body, finishing machine, and clamshell buckets.

Autocar Chassis

The Autocar Company, Ardmore, Pa., will exhibit two special chassis at the road show of the American Road Builders' Association, in St. Louis, January 10 to 16, inclusive.

One unit in the Autocar exhibit will be the *Autocar Model C* chassis, equipped with a 3-yard Paris Transit Mixer body. The Autocar Model C, with 186-inch wheelbase, is engineered to meet stresses imposed by the various types of rotating, concrete-mixer body.

A companion chassis to the Model C is the *Autocar Model SCHS* which will also be exhibited at the road show, equipped with a Wood hydraulic 3½-yard body with extension sides and two division boards.

Industrial Literature

Floor Floating Machine

A leaflet describing the Kelley electric floor machine, for floating concrete and grinding concrete and terrazzo floors, has recently been issued by the *Kelley Electric Machine Company,* Buffalo, New York.

Rough floating is done directly after the concrete is tamped and the first steel trowelling follows immediately. A smooth floor, free from fan marks, is secured, and a minimum of steel trowelling is required when the machine is used, it is claimed.

The finishing of terrazzo floors is illustrated and an area of 200 to 250 sq. ft. of floor can be covered in an eight-hour day, it is stated.

Air Compressor Book

A new 16-page book telling about the Davey air compressor, "for taking 'the grief' out of compressed air," has just been published by the *Davey Compressor Company,* Kent, Ohio.

The air-cooling method employed is outlined and various features, including the light weight, sturdy clutch, and portability are described. Numerous illustrations show units in use on various types of jobs.

Concrete Insurance

Under the title of "*Concrete Insurance,*" the *Vaso Manufacturing Company,* Seattle, Washington, has published a broadside on its new admixture known as Vaso.

Its use is recommended to increase the workability and flowability of concrete and insure the placing of concrete that will not be porous. Its use in the ready-mix plant, by the architect, and by the contractor are described.